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IRRADIATION IN THE TREATMENT OF HYPERTHYROIDISM[1]

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THE importance of hyperthyroidism is indicated by the fact that a great medical organization such as this is devoting an evening to the discussion of its treatment. The fact that you are considering the subject from the standpoint of surgical, roentgenologic, and medical treatment indicates that good results have been accomplished by each method. Four phases of this subject, then, remain for discussion:

1. Is any one method so much superior to others as to make it applicable to all cases, with the abandonment of the other two?
2. Shall the cases be selected according to the indications found in the individual patient?
3. Shall all three methods be combined?
4. What shall be done when any one, or all, of the three methods fails?

It is a great honor and also a great responsibility that has been given me to reply to these queries from the standpoint of the radiologist, whose branch of medicine is very young. As Christie has pointed out, it was about thirty years before the value of the surgical treatment was recognized by the internists; and now, after nearly thirty years, the value of radiologic treatment is being recognized. Each group of practitioners has been called upon to treat the failures of the others. This has given each of us in turn a sense of superiority, or of humility. But this vacillation probably only demonstrates our general lack of knowledge in the selection of the cases, our lack of skill in the application of the method of treatment, or our fault in not making use, at the proper time, of two or three of these methods.

In dealing with hyperthyroidism, we must assume that the patient has an excess of secretion from the thyroid gland, either because of an over-production of the glandular tissue, or because of an over-activity of the normal amount of glandular tissue. The internist aims to reduce the activity by rest and medication, thus reducing the irritability of the gland. The surgeon reduces the activity by cutting off part of the blood supply, or by removing part, or all, of the gland. And the radiologist aims to reduce the secretion both by the reduction of the hypertrophy and by decreasing the activity of the secreting cells. When a patient is under irradiation treatment, the hyperactivity of the cells is first reduced, as is shown by the clinical observation that the symptoms of thyrotoxicosis disappear more rapidly than the goiter.

In 1923, Weil found that, because of the enormous richness in capillaries, the circulation for 100 gm. of the thyroid gland is 500 c.c. of blood per minute, while for the same

[1]Presented by invitation March 16, 1932, before the Bronx County Medical Society, N. Y., in a symposium on hyperthyroidism.

quantity of kidney it is only 100 c.c., and for the inactive musculature only 12 c.c. per minute. This gives the reason for the enormous amount of toxin which can escape into the blood in a short time.

By transplanting particles of the thymus gland of patients suffering from Basedow's disease, Bircher, also in 1923, was able to produce typical Basedow's disease in dogs. This indicates that not only the thyroid, but also the thymus, is involved in Basedow's disease, explaining why it is necessary for us to include this gland area in our treatment.

It has been found that over-active glandular tissue is more sensitive to irradiation than normal. The fact that normal glandular tissue is not easily affected by the rays explains, in part, why we very rarely observe hypothyroidism after our treatment. For example, Ivy, Orndoff, and others found that it took about six human erythema doses to depress the functions of the submaxillary gland in the dog. This is about twice the amount of the total irradiation given for hyperthyroidism in from six to eight months, instead of one dose as was given to the dogs. We have proof also of the resistance of the normal thyroid tissue in the fact that the enormous amount of irradiation given in the treatment of carcinoma of the larynx is not followed by hypothyroidism.

Walter, Anson, and Ivy[2] state that the experimental literature at hand indicates that normal thyroid tissue is resistant to X-rays, and conclude from their own studies that "the normal thyroid of the dog is quite resistant to X-rays and degenerative changes are not caused by the dosage used in the experiments, which is a dose known to be of some clinical value," and "in the dosage used do not cause extensive proliferation of connective tissue. . . . *The results indicate that the clinical dosage in the treatment of hyperthyroidism will not injure the parathyroids.*" None of our patients treated by irradiation has shown any tetany.

It would seem logical that the internist's services would be most valuable, no matter whether a patient is treated by surgery or irradiation. Therefore, when the internist has removed the causes and physiologic rest is not sufficient, then either surgery or irradiation, and sometimes both, must be used.

When surgery seems advisable, one must overcome the objection to operation; the patient must be hospitalized; there are added the shock and risks of an operation, and the surgeon must guess as to how much glandular tissue he shall remove. The more expert surgeon, who has the greatest skill and the keenest judgment, will obtain the best results, for he will know best how much to excise and will do it with the least risk and shock.

When irradiation is decided upon, there is no pain, no discomfort, no shock. With modern skill there should be no risk, and certainly no deaths, due to the treatment. Only rarely need the patient be hospitalized. In many of our milder cases, the patient has continued with his, or her, occupation, and yet good results have been obtained.

Surgery has the advantage of producing more prompt results, but this difference is not so great as would at first appear. With irradiation, we usually see some improvement at the end of a month, and very definite improvement at the end of two months. If the surgeon prepares the patient for two weeks before operation, allows him two weeks to recover from the operation, and a month for convalescence, the difference in time is not so great. At the end of these two months, however, we may generally expect a more complete relief of symptoms from surgery than from irradiation, because the surgeon removes the excess of glandular tissue at once, while with irradiation we reduce the hyperactivity and the hypertrophy,

[2]O. M. Walter, B. J. Anson, and A. C. Ivy, RADIOLOGY, January, 1931, XVI, 52-58.

or hyperplasia, gradually. This is a slow and progressive effect.

If the surgeon has sufficient experience, skill, and judgment to remove just the right amount of glandular tissue, then the patient will be entirely relieved of symptoms. But if he removes too little, there will be only an amelioration, and, if he removes too much, hypothyroidism will develop. In other words, the surgeon has one guess, and the radiologist has from five to eight guesses.

For this reason, it is my custom to give one series in which a 40 per cent erythema dose is given over each of four fields, and then to repeat in three weeks, then in four weeks, after which the interval is governed by the amount of relief of symptoms. It is our aim to produce results, but, generally, we require from five to eight series. If, after three or four such series, there is no definite improvement which justifies us in assuming that the patient will get well, an operation should be urged upon the patient. Very few cases have had to submit to operation.

This naturally raises the question of increased difficulty in operation, when necessary, because of the previous irradiation. There is no theoretic or practical reason for increased difficulty after such an amount of irradiation as indicated above, which involves less than a total of 150 per cent of an erythema dose distributed over a period of three months. When the treatment is carried to the extent of producing a fibrosis, then operation will be made more difficult. It requires more than eight series such as I have described above to produce fibrosis, atrophy, or telangiectasis. In the past, when it was difficult to measure the exact amount of irradiation, or when radiologists failed to take account of the total radiation value, such fibrotic changes were produced. *It is the total amount of irradiation that brings about degenerative changes, whether given in one large dose or many small doses.*

It is the general opinion of radiologists that preliminary irradiation is justified in all cases of hyperthyroidism in which the goiter, if present, is not causing sufficient mechanical pressure or in which the symptoms are not so acute as to make delays dangerous. It has been argued that the delay of two or three months before an operation, if necessary, will lead to damage of the heart. One must realize, however, that it usually takes some time until an operation is decided upon or until the patient will consent. This time can certainly be utilized to advantage by preliminary irradiation. If there is a prompt response, then an operation can be avoided. Holzknecht[3] stated that not one case is found in the literature proving that prolongation of the irradiation resulted in unnecessary damage to the heart.

The operations certainly must be confined to those cases in which there is a goiter, whether this be hyperplasia or an adenoma. There are, however, a group of cases of hyperthyroidism in which there is no enlargement of the thyroid, and no palpable tumor. These cases respond to irradiation in the same manner as the goiter cases, furnishing the best proof of hyperactivity of the cells. They also evidence very definitely that irradiation restores such hyperactivity to normal.

In our experience, the toxic adenomas, while they may not entirely disappear, respond to irradiation in the same way as the hyperplastic variety of goiter with hyperthyroidism. Generally, there is at least a reduction. It has been claimed that all adenomas should be removed, because of the danger of later malignant degeneration. Since, however, carcinoma of the thyroid seems to be especially sensitive to irradiation, we may in fact be preventing or curing such early degeneration. In this connection I have been corresponding with Dr. Holmes, Dr. Loucks, Dr. Soiland, Dr. Christie, Dr. Ginsburg, Dr. Orndoff, Dr.

[3]Guido Holzknecht, Strahlentherapie, 1928, XXX, 605-612.

Stevens, and Dr. Portmann. Their observations, together with my own, cover over 1,200 cases of toxic adenoma, and none of us has seen a case in which there was found malignant degeneration after irradiation. It is likely that, in this number of cases, there were a few in which, if they had been operated upon and examined microscopically, some early malignant degeneration would have been found.

Dr. A. C. Ivy, of Chicago, who is doing some excellent research work, writes:

> We had a young dog with an adenoma of the thyroid on which we did a biopsy and then gave an X-ray series. The adenoma disappeared slowly. We observed the animal for two years, at the end of which time he was killed. No evidence of malignant degeneration was found. We wanted to do a large series (10 or 20) of dogs, but did not have funds available. That kind of work is quite expensive and dogs are the only animals that quite commonly manifest adenoma of the thyroid spontaneously.

Bensley has shown that a high protein diet fed to opossums, when confined to cages, will induce a marked hyperplasia of the thyroid. Ivy and his associates have shown that roentgen treatment will prevent this hyperplasia to a considerable extent.

Technic.—In general, I depend upon the roentgen rays, using the so-called low voltage technic: 130 K.V., 5 ma., 8 mm. at 30 cm. distance, filtered through a combination filter of copper and aluminum equal to 6 mm. of aluminum. With my equipment, this gives 40 per cent of an erythema dose. We use two anterior and two posterior fields, each about 5×15 cm., to include both the thyroid and the thymus and to expose all parts of the glands equally. The larynx and the remainder of the body are protected. This series of four doses is given in succession in one day, being repeated in three weeks, then in four weeks, increasing the interval according to the improvement obtained. We always aim to give as little as possible, stopping when the basal metabolism falls to +15 or +10.

I have not observed an increase of symptoms following the first irradiation. Such effects have, however, been observed by others (Pordes, Goette).

We have treated with radium only a few cases which were unsuitable for roentgen therapy. Loucks and Ginsburg prefer radium, and have obtained excellent results. Surely equally good results can be obtained with radium as compared with X-rays. It would seem that radium is preferable for patients who cannot come for treatment, or for whom the excitement caused by the machinery would be harmful. In one very acute case in which we applied radium, there was no interruption of the symptoms, the patient dying within a few days. It was the opinion of all that the patient would have died in the same time if no such treatment had been given.

To allay the nervous symptoms, we have been using quinine hydrobromide as recommended by Bram in 5 gr. doses, given three times a day during at least the first three weeks. It is remarkable, as Bram reports, that these patients can take even larger doses without the symptoms of cinchonism, which would occur in a normal individual. We have not found the use of iodine helpful, except in a few cases of exophthalmic goiter in which it was used for a short time. It seems to be the general opinion of radiologists that iodine should not be used in conjunction with irradiation. Holmes, however, found it useful for a short time. Surgeons find iodine useful to prepare for operation, but they do not advise its continuous use.

Rest is always helpful and should be carried out so far as is practical. In many of our cases the patients have had to continue with their occupations. I always advise, however, to get as much rest in bed as is possible; to avoid all unnecessary physical

or mental exertion or excitement; to avoid all stimulants, including tea and coffee; never to stand when they can sit, and never to sit when it is possible to lie down, even for a few minutes. These rules are especially important during the first month.

Results of Treatment.—After all, the final results are what count. Unfortunately, there are at present no large irradiation clinics for hyperthyroid cases, and no comprehensive statistics. But the fact that favorable statistics are gradually accumulating, even with the good results already obtained by surgery, shows that there is value in this method. In a previous paper,[4] Dr. Vastine and I reviewed the reports of 87 authors.

Krause[5] has collected 1,342 cases from 31 authors which were reported with sufficient detail to be of value. He found good results on an average in 82 per cent of the cases and poor results in 18 per cent. The general report is that about 65 per cent become symptom-free and remain well; approximately from 15 to 20 per cent more are improved and return to their occupations, and from 10 to 20 per cent do not improve.

The record of my private cases treated for hyperthyroidism have been reviewed for me by my associate, Dr. Jacob H. Vastine. The hospital cases have been more difficult to follow and, therefore, they are not included. The results may be stated briefly as follows:

TABLE I.—SUMMARY OF CASES TREATED

Cases with hyperthyroidism treated with roentgen rays	361	
Cases treated with radium	4	
Non-toxic cases treated	50	
Malignancies	26	
Total cases treated		441
Simple or non-toxic goiters in which we advised against irradiation, which were not treated		153
Total		594

[4]G. E. Pfahler and J. H. Vastine, Am. Jour. Roentgenol. and Rad. Ther., October, 1930, XXIV, 395-411.

[5]P. Krause, Strahlentherapie, 1927, XXVII, 393-412.

Under *hyperthyroidism,* or *thyrotoxicoses,* we have classed all exophthalmic goiters, all toxic adenomas, and those which had a high basal metabolism associated with the characteristic nervous symptoms, even when no goiter and no exophthalmos are present.

We have *classed as cured* those cases in which the basal metabolism, taken routinely since 1921, is between +10 per cent, and —10 per cent; the pulse has returned to normal; the weight has increased, approximately, to what it was before the onset of toxic symptoms, and nervous and other clinical manifestations have subsided, and in which the goiter has either completely disappeared or is so involuted as to be entirely unobjectionable from a cosmetic standpoint.

We have *classed as improved* those cases in which the basal metabolism is within normal limits or is markedly decreased; in which all clinical signs of thyrotoxicosis have disappeared, except a residual myocardial deficiency, which was present before the beginning of irradiation; or inoperable cases given irradiation to reduce the toxicity and to prepare them for operation.

We have divided all cases into "mild," "moderate," and "severe." The summary of results is shown in Table II (see next page):

Discussion.—Table II shows:

1. The percentages of cures in the "mild" and "severe" cases are practically the same, 52.7 per cent and 52.3 per cent, and those which are "improved" approximately 31 per cent, or 83.5 per cent which have been cured or greatly benefited.

2. The "moderate" cases show 63.8 per cent of cures, 25.4 per cent improved, and only 10.8 per cent which were not benefited.

3. Taking all groups, approximately 57 per cent are cured, 31 per cent improved, and 12 per cent not improved. The total cured, or markedly benefited, is 87.8 per cent.

4. The average number of treatments (series of four fields usually given on one day) was, for the cured cases, 6.1; improved, 5.7, and the unimproved, 3.7.

5. The average time that these patients were under observation was, for the cured, 5.2 years, and for the improved 2.2 years.

Of the 361 cases treated for hyperthyroidism, there were 37 in which there was a hyperactive gland but *no palpable glandular enlargement.*

Of these, 22, or 64.7 per cent, were cured.

Seven, or 20.6 per cent, were markedly improved.

Five, or 14.7 per cent, were not improved.

Three could not be traced.

Of the five patients not improved, one died from hyperthyroidism after only two treatments. One died from tuberculosis, having had only one roentgen treatment. One other case had only one treatment and that without benefit. Two others had five and nine treatments, respectively, without very marked improvement, and subsequently operations were performed. Of the 361 cases, 28 were subsequently operated upon, or 7.8 per cent. Twenty-five of the 361 cases were post-operative recurrences, or 7 per cent.

Of these, 10 cases, or 40 per cent, were cured.

TABLE III.—HYPERTHYROIDISM—PERMANENCY OF RESULTS IN 293 CURED OR IMPROVED CASES

Time since treatment	Mild cases	Moderate cases	Severe cases	Total
Less than 1 year	16	21	14	51
1 to 3 years	14	28	25	67
3 to 5 years	8	9	26	43
5 to 10 years	10	32	39	81
Over 10 years	14	25	12	51
Total	62	115	116	293

TABLE II.—HYPERTHYROIDISM—361 CASES

	Cured	Markedly improved	Not improved	Unknown
Mild				
Number of cases	39	23	12	14
Percentage	52.7	31.0	16.2	
Average number of treatments	3.9	3.9	4.7	1.8
Average time observed, years	4.7	1.5		
Moderate				
Number of cases	83	33	14	8
Percentage	63.8	25.4	10.8	
Average number of treatments	6.6	4.9	4.1	2
Average time observed, years	5.7	1.5		
Severe				
Number of cases	68	47	15	5
Percentage	52.3	36.2	11.5	
Average number of treatments	6.9	7.3	2.6	1.4
Average time observed, years	5.1	3		
Total				
Number of cases	190	103	41	27
Percentage	56.9	30.9	12.2	
Average number of treatments	6.1	5.7	3.7	1.7
Average time observed, years	5.2	2.2		
Total cured or markedly improved—87.8 per cent				

Ten cases, or 40 per cent, were markedly improved.

Five cases, or 20 per cent, were not improved.

Eighty per cent were cured or markedly improved.

In 19 patients, 25 pregnancies were carried to successful termination without recurrence of the previous goiter or toxic symptoms.

Sixteen patients of whom we have a record developed definite telangiectasis, 3.6 per cent of the 441 cases treated.

Metabolic rate below 10 following treatment was produced in only four, or 9 per cent, of 441 cases treated. *In only one of these is thyroid extract necessary to relieve symptoms.*

In three cases which were not responding satisfactorily, we tried treatment over the cervical sympathetic ganglia and over the suprarenals, but with no appreciable effects. Hoarseness did not develop, because the larynx and arytenoids were protected. Two cases developed a severe trachitis, but these two had more than the eight series, and the effects may not have been due to the irradiation.

SUMMARY AND CONCLUSIONS

A review of the literature shows a progressively increasing recognition of the value of both roentgen rays and radium in the treatment of thyrotoxicosis. The results obtained by irradiation are equal to those obtained by surgery, with less shock or risk to the patient. The basal metabolism can be gradually reduced to normal, and there is practically no danger of producing hypothyroidism. None of my cases has developed tetany. We can assume that no harm has been done to the normal parathyroid.

A review of 361 cases treated for thyrotoxicosis shows cure or marked improvement in 87.8 per cent. It would seem that we must answer our queries as follows:

1. Not surgery, nor irradiation, nor medication can be depended upon to cure all cases and no one is so much superior that we can recommend it to the exclusion of the other two. Our records show almost exactly as many cases referred by us to the surgeon as were referred to us after surgery had failed. Usually the patients do not reach either the surgeon or the radiologist until the internist has failed to obtain satisfactory results.

2. No definite rules can be laid down at present for the selection of the method for the individual patient. It is the general opinion of radiologists that all cases which are not seriously involved by mechanical pressure, or so acute as to make delay of a month dangerous, should be treated by irradiation.

3. Irradiation and every valuable method of medication can certainly be combined to advantage. If there is no definite improvement after two or three months, surgery can still be used. The delay which always precedes operation can be used to advantage in this manner.

4. When irradiation fails, surgery can still be used; when surgery fails, irradiation can be used. Medication and the advice of the internist are of value in all cases, but there will remain a small number in which we all will fail.

PART III

FINDINGS OBSERVED IN THE GASTRO-INTESTINAL TRACT

By THE COLE COLLABORATORS

BY observing barium within the lumen of the gut in roentgenograms of full size, with or without the grid, and in small roentgenograms, with or without the grid and with or without pressure, *findings* are obtained which enable us to determine definite characteristics of the mucosa in various regions of the tract.

Four fundamental findings form the criteria for exploring the mucosa of the gastro-intestinal tract:

(1) The lumen of the tract viewed in profile.
(2) Special folds of the mucosa viewed on edge.
(3) Pliability of the mucosa to peristaltic contraction.
(4) The pattern of the mucosal folds or rugæ.

All of these are well known. Some are so familiar as to be regarded with contemptuous indifference. Still others, with slight modifications, are now the vogue.

The object of this communication is to evaluate these four fundamental findings, regardless of the popularity of prevailing fashions. In this evaluation the gastro-intestinal tract will be considered under five distinct regional headings: (1) esophagus, (2) stomach, (3) cap, (4) small intestine, and (5) colon. Each of the four fundamental findings may be observed in each of the five regions.

FIRST FUNDAMENTAL FINDING

(The Lumen of the Tract Viewed in Profile)

The contour of the surface of the mucosa as it appears in the silhouette of the lumen of a hollow viscus when moderately filled with an opaque meal or air, constitutes the first fundamental finding. The esophagus distended in this manner and viewed from different angles (Fig. 20) serves to illustrate this finding. Such a procedure may be likened to one walking around a tree examining its bark and noticing whether it is smooth or rough, bulged as by a growth, or barked as by an ulcer (Fig. 66). Alterations in contour due to physiologic changes are variable and not constant. Any organic lesion which projects into the lumen of the gut diminishes the space occupied by the barium and causes what is known as a "filling defect." Any break in the mucosa, or any abnormal pouching of it, allows the barium mixture to protrude beyond the normal contour of the organ. This protrusion is defined as a crater, niche, or diverticulum. This first finding is applicable in all five regions of the gastro-intestinal tract and will be described and illustrated in each region.

Esophagus.—A diverticulum of the upper end of the esophagus, observed in the postero-anterior and lateral directions in Figures 70 and 71, exemplifies the manner in which barium may protrude beyond the normal contour of the esophagus. This illustration also shows the manner in which the neck of the diverticulum joins the esophagus.

An extremely small area of malignant induration of the mucosa, which involves only part of the circumference of the esophagus (Fig. 72), protrudes into the lumen and displaces the barium, thus giving an alteration from the normal contour. This illustrates the first fundamental finding which enables one to detect small pathologic lesions.

Stomach.—The contour of the lumen of the normal stomach viewed in profile in various directions has been illustrated in Figure 5. Alterations in the lumen caused by pathologic lesions of the mucosa are evidenced, firstly, by growths of the mucosa or other structures which protrude into the lumen of the stomach, and, secondly, by a break in the mucosa as by an ulcer which allows the "fluid cast" to protrude beyond the normal contour. A case of the first kind is illustrated in Figure 73, where a growth is observed to protrude from the greater curvature of the antrum into its lumen. The surface of the central portion of this growth has been destroyed, resulting in an ulcer. The surgical specimen of this case illustrates the manner in which ulcerating malignancies protrude into the lumen of the stomach (Fig. 75). The diagnosis of neoplasms of this type may be based on a single roentgenogram or, at most, on two or three roentgenograms for the reason that gastric peristalsis, as observed by serial roentgenography, is not essential to the diagnosis.

A break in the mucosa, as by an ulcer, allows the fluid cast to protrude beyond the normal contour and therefore appears as a crater or niche. Such a break is shown in Figure 74. This ulcer was removed by surgery prior to the time that we began our study of the pathology of ulcer, so that a section of that specimen is not available for photographic illustration. However, a photograph of a longitudinal section of a similar ulcer is shown in Figure 76.

Cap.—The term "cap" was first applied to two or three cm. of the gastro-intestinal tract just distal to the pyloric valve in an article published in "Archives of the Roentgen Ray," April, 1912. This area was then described as one of the most important regions in the entire gastro-intestinal tract. The text as it was originally written, more than twenty years ago, so accurately describes the findings as we have now observed them that we are quoting *verbatim* from this original article, and we have had a special page of illustrations (Fig. 77) struck off from the original half-tone plate that illustrated the article and which, fortunately, we still possess.[1] The numbers which the reader will find in the quoted portions of the 1912 article refer to the small figures shown in the sheet of illustrations just mentioned.

The peristaltic waves of the small intestine are so rapid and small that it is

[1]The reader will find Figure 77 following Figures 88 and 89, out of its numerical order: this arrangement, which makes for better binding, was decided on after the figure numbers had been allotted.

difficult to study them either fluoroscopically or radiographically. We can, however, radiographically distinguish the ileum by the coagulated appearance of the bismuth contents, and the jejunum by the flocculent appearance (Fig. 1). This appearance is constant in normal cases, but may be modified in pathological conditions and in cases of intestinal motor inefficiency.

The second and third portions of the duodenum are usually readily identified by their shape and position (Figs. 2 and 3), unless the intestinal peristalsis is so active as to have a tendency to suck the food away from the pyloric sphincter (valve) more readily than it is allowed to pass through. In such cases I have pursued a method of artificial dilatation of the duodenum, which will be described later on.

The first portion of the duodenum deserves special attention. Anatomically and physiologically it has always been considered a part of the small intestine. Since writing this paper I have learned that Mayo has suggested, both on account of its embryology and its acidity, that the first portion of the duodenum should be considered a part of the stomach. Radiographically it should undoubtedly be considered as a part of the stomach. It is dilated into a cap which surmounts the pylorus, and corresponds in size and shape with the pyloric end of the stomach. It has absolutely no resemblance to the small intestine. Its motor phenomenon corresponds with the gastric cycle, and has no resemblance to the small, rapid, peristaltic contractions of the remaining portions of the duodenum. [The similarity of the motor phenomenon of the cap to that of the stomach has since been proven incorrect and will be described later.] The acidity of the contents of this duodenal cap may account for prevalence of ulcers, over 90 per cent occurring in this portion of the duodenum. Considering its embryology, its acid contents, its motor phenomenon, its surgical importance, and the very important part that its radiological appearance plays in the diagnosis of gastric and duodenal lesions, it should be dignified by a separate name. Its appearance and position, sitting like a cap on the pylorus, immediately suggest its name. Hence, for convenience of description, I shall call the first or ascending portion of the duodenum the "cap."

The "cap" was more popular than scientific and several of my more scientific friends urged that we adopt a scientific term for the region of the gastrointestinal tract which we believed to be so important. At that time I was working on the possible theory of the cap being an analogue of the second stomach in ruminating animals. With this theory in view I consulted with Dr. Tower, who was then curator of the New York Museum of Natural History. He was extremely interested in the subject and after spending a day or two with me we came to the conclusion that the two regions were not of similar origin. I then discussed with Dr. Tower the question of selecting a proper name for the region. Observing the size and shape of the cap as demonstrated roentgenographically, he noted its similarity to a brimless cap which was given to the Roman slaves, when they were liberated, as a token of their liberation; this cap was called "pilleus." The especial similarity attracting his attention was the manner in which the descending duodenum hung down like a tassel. The name which I had previously selected was "toga," because of the similarity of the cap worn as an insignia

by the Reds. Dr. Tower drew my attention to the fact that the idea of the toga was obtained from the "pilleus." Therefore, in a subsequent article, we discussed the cap under the title, "Physiology of the Pylorus, Pilleus Ventriculi and Duodenum as Observed Roentgenographically."

This cap varies in size, shape, and position, but a normal cap can usually be differentiated from a pathological one. It varies in different patients. Figures 4, 5, and 6 represent different types of the cap. It varies with the posture, but without pressure on the abdomen, as described in the first article, there is no tension on the first portion of the duodenum; the cap is symmetrical, its lines are clear-cut and well defined, as shown in Figure 7. But with the same patient in the erect posture the distended stomach drags on the cap, and there is usually an attenuated appearance of the cap, as shown in Figure 8. Frequently, in cases in which the cap is not completely filled, the level of the chyme is discernible (Fig. 9). Occasionally above the chyme an accumulation of gas may be seen, similar to that usually seen in the stomach (Magenblasse). The cap varies during each gastric cycle. Sometimes it sets up on the head of the pylorus in a perfectly proper manner (Fig. 10), separated from it by about 3/16 of an inch; at other times it drops down over the head of the pylorus, like the lady's "peach-basket" hat (Fig. 11). During the stage of diastole the stomach contents drop away from the cap, and it then has the appearance of having been "blown off," as in Figure 12. The cap also varies with the activity of the intestinal peristalsis. If the peristalsis of the second and third portions of the duodenum is so active as to withdraw the food as fast as it passes through the pyloric sphincter (valve), the duodenal cap may not be dilated to its full size.

There may be an angulation of the cap at the pyloric sphincter (valve). The cap may be displaced to the left, or, what is more likely, the pyloric end of the stomach is drawn to the right, while the cap is held in its normal position by the gastrohepatic ligaments. This condition is illustrated in Figure 13. In Figure 14 there is an irregularity on the greater curvature near the pylorus, which may indicate the attachment of adhesions to the pyloric end of the stomach, drawing it to the right.

In other cases the angulation may be due to adhesions binding the pyloric end of the stomach to the lower surface of the liver. This does not allow space for the cap to surmount the head of the pylorus, and it is displaced backward and to the right, as illustrated in Figure 15.

In all of those cases there was more or less evidence of obstruction; but in none of these, except possibly in the last, was there any evidence of adhesions contracting the lumen either of the pylorus or duodenum.

The clear space between the cap, just described, and the bismuth contents of the pyloric end of the stomach during the systole indicate accurately the pyloric sphincter [now known as "valve"]. The breadth of this clear space varies slightly with the muscular development of the patient, but it is one of the most constant factors in gastro-intestinal radiography. It should be 3/16 inch, varying from 1/8 to 1/4 inch; both outlines should be clear-cut and well-defined during the gastric systole, as illustrated in Figures 16, 17, and 18. The lumen of the pyloric sphincter should be in the center of the sphincter, and about 1/8 inch in diameter. The variation of the radiographic appearance of the pyloric sphincter during different phases of the gastric cycle is due in part

to the pressure of the food against the pyloric sphincter, as shown in Figures 19 and 20.

There is some question whether the pyloric sphincter takes part in the motor phenomenon of the stomach [as Cannon calls it, the "keeper of the gate"], contracting and relaxing during each cycle, or whether it remains contracted, the food being forced through it by the peristaltic action of the stomach. Personally, I consider the pyloric sphincter as a "butler," guarding the entrance of the intestine, and closing the door during diastole to prevent the food from passing back into the stomach. I believe that the relative strength of the pyloric sphincter (the butler) to the peristaltic contraction of the stomach (the cook) is one of the most important factors in functional derangements of the digestive tract. If the pyloric sphincter is too strong, the stomach may be over-distended with food, and yet the small intestine may be starved. On the other hand, if the pyloric sphincter is weak and the peristaltic contractions are too strong, improperly prepared food will be served to the intestine.

During the stage of systole, with the patient in the erect posture, the food is pressed up against the surface of the pyloric sphincter, and we have a clear-cut, well-defined outline of the sphincter, as is shown in Figure 21; but during the stage of diastole the food drops away from the pyloric sphincter, and there is a wide space between the bismuth contents of the cap and that of the pyloric end of the stomach, as is shown in Figure 22.

In the interpretation of the radiographic plate, great care should be taken not to interpret this space as evidence of obstruction of, or adhesions to, the pylorus.

The relation of the pylorus to the umbilicus varies with the size, position, and type of stomach. The position of the umbilicus itself also varies with the build and obesity of the patient and the flabbiness of the abdominal wall. The relation of the pylorus to the body of the stomach is much more important, and varies with the type of the stomach, as is shown in Figures 23, 24, 25. The most important point, however, is the relation of the level of the chyme to the pylorus when the patient is in the erect posture. If the upper level of the chyme is three or four inches below the pyloric sphincter (valve), and the peristalsis is inefficient, as indicated in Figure 26, how is the chyme going to get out of the pylorus even if the latter is wide open? Figure 27 is of the same patient in the prone posture, with the abdomen flat on the plate. These two plates illustrate the relative value of the two different postures in determining the shape and contour of the stomach, particularly when the stomach is dilated and atonic.

Artificial Dilatation of the Duodenum.—When the chyme is drawn away from the pyloric sphincter (valve) by unusually active intestinal peristalsis it is difficult to detect the second and third portions of the duodenum. In such cases I have adopted the following method, which was described in my article, "The X-ray Diagnosis of Pyloric and Duodenal Lesions," read before the American Association of Obstetricians and Gynecologists at Louisville, Ky., Sept. 29, 1911. A second paper, on "Artificial Dilatation of the Duodenum for Radiographic Examination," was published in the "American Quarterly of Roentgenology."

The lumen of the entire duodenum and upper portion of the jejunum can be examined by the following procedure: The patient swallows an Einhorn pyloric dilator. This is a small metallic ball and rubber bag attached to a fine rubber tube, the rubber bag collapsing round the tube just behind the ball. The whole

apparatus is as easily swallowed as the old-fashioned pill. This dilator may be administered with the food the day before, or given three or four hours before the examination, the patient assuming a position which will allow it to pass into the duodenum and jejunum.

The small rubber bag, which is surrounded by a silk bag about the size of the lumen of the duodenum, is then inflated with air, and acts as an intestinal obstruction. A meal of bismuth and buttermilk is then given by mouth, and passes readily into the duodenum, the temporary obstruction preventing the bismuth from passing on through the jejunum. The duodenum is dilated by the bismuth and buttermilk, and a radiograph shows perfectly the contour of the dilated duodenum.

I am indebted to Dr. Max Einhorn for the case illustrated in Figures 28, 29, and 30. The dilator was passed into the stomach by Dr. Einhorn about fourteen hours before the examination. Forty plates were made, with an interval of about five minutes between each two exposures, some before and some after the administration of the bismuth.

The first plate made after the bismuth was administered showed the stomach and cap distinctly, but the second and third portions of the duodenum were not visible. Then the second portion began to fill, as shown in Figure 28, the tube and bag being in the jejunum. Later the third portion filled, and Figure 29 shows the entire duodenum artificially dilated. In both Figures 28 and 29 the bag is not so completely inflated as it should be, but in Figure 30 one readily sees the bag properly inflated.

This case is interesting as showing how far the dilator may pass into the small intestine and yet be withdrawn without causing any unusual sensation. The dilatation of the duodenum would have been more complete if the tube had passed only into the first portion of the jejunum, and the inflation of the bag had been as thorough as in Figure 30.

The following modification of Einhorn's dilator will, I believe, be of great value: The tube is surrounded by a second tube slightly larger than the first. This outside tube terminates just behind the rubber bag, and through it the bismuth and buttermilk may be injected and aspirated directly into or from the duodenum. In this way the exact amount of the distention of the duodenum may be diagnosed.

Radiographic examination, besides showing adhesions from duodenal and gastric ulcers and gall-bladder infection, also enables us to examine the head of the pancreas, which can be more perfectly outlined by the duodenum, as suggested by Dr. Crane. In some cases I have been able to clearly demonstrate the shadow of bismuth in the canal of Wirsung. [This was probably a duodenal diverticulum adjacent to the ampulla of Vater, termed by the French "peri-vaterans."]

This ends the quotation, and as I read the text and carefully observe the illustrations of the original article I marvel that at that time I should have had sufficient material to accurately describe all of these findings. We have already described the manner in which this small region of the tract sets up on the pyloric end of the stomach like a brimless cap, and that this term "cap" is applied because this region does resemble a cap. The term "duodenal" is often erroneously applied to it, and in the past (and by some still) this region was called the first or ascending portion of the duodenum.

However, considering that it has none of the characteristics of the small intestine the terms "duodenum" and "bulbus duodeni" are misnomers.

The appearance of the fully distended normal cap and its similarity in appearance with the pyloric end of the stomach is shown in Figure 37. The similarity in appearance of the cap and pars pylorica is strikingly shown if one covers the pyloric valve with a pencil. The outline of the distended normal cap is clean-cut and smooth. The change in outline of the base of the cap produced by contraction of the fan-shaped muscle of the pyloric canal is shown in Figures 31 and 32.

Alterations in the contour of the cap caused by pathologic lesions are largely limited to an encroachment upon the lumen of the cap. The usual exceptions are the localized dilatations of the uninvolved part of the cap proximal to an area of stenosis (Fig. 85). These are often called "pseudo-diverticula." Diverticula occur frequently in the duodenum close to the cap and are not infrequently erroneously interpreted as being of the cap proper, but true diverticula of the cap are extremely rare. We have never seen one.

Occasionally one sees in profile the crater of an ulcer which projects beyond the margin of an otherwise normal appearing cap. In these cases the inflammatory reaction around the ulcer is so slight that there is no appreciable flattening of the contour of the cap adjacent to the crater (Figs. 78 and 79).

More commonly the crater of an ulcer of the cap protrudes outside of the contour of a cap which is diminished locally in size by induration of the cap wall (Figs. 80 and 81).

Alteration in the contour of the cap by changes which encroach upon the lumen is common and familiar to all. These changes may be an enfolding of the entire thickness of the wall of the cap by a veil or band of adhesions (Fig. 82), induration around an ulcer (Fig. 83), and bands of scar tissue which radiate from the site of an ulcer (Figs. 84 and 85), or which remain as the residual change of a healed ulcer.

Small Intestine.—The variations in contour of the small intestine are principally caused by diverticula into which the barium passes, and the shadows of these diverticula protrude beyond the normal contour of the gut (Fig. 90). The lumen of the small intestine may be diminished in diameter by local bands of adhesions or tuberculous infiltration (Figs. 91 and 92), and occasionally one observes a malignant lesion or a non-malignant polyp which protrudes into the lumen.

Colon.—The contour of the colon may be altered by growths which protrude into it (Figs. 93 and 94), causing filling defects similar to those observed in the stomach and constituting the most important finding in this region, or it may be altered by pouches or diverticula (Fig. 95). Diverticulosis of the colon is a very common finding and, unless the diverticula are the seat of inflammatory reaction, they are of relatively slight clinical significance. However, when these diverticula do become inflamed the mucosa becomes the seat of an area of induration which encroaches upon the lumen of the colon, and causes a filling defect that may completely obstruct it. This is sometimes difficult to differentiate from malignancy.

SECOND FUNDAMENTAL FINDING

(Special folds of mucosa viewed on edge)

The second fundamental finding is the thickness and appearance of special muco-membranous folds, such as the plica angularis and the pyloric valve, viewed on edge. The principle involved in this finding is well illustrated by a sandwich (Fig. 67), that is, two slices of bread are likened to the double layer of mucosa and the filling is similar to the submucosa. Thus, by viewing the sandwich on edge, one determines whether or not there are any lumps in the filling, or a piece nibbled out of the side as by a mouse. Thus, one may view the folds and note whether there is a malignant or non-malignant lump in the submucosa, or if the mucosa is nibbled away by a mucosal ulcer.

Sulcus Angularis.—The second fundamental finding is observed in roentgenograms of the stomach as the sulcus angularis. This finding is most typically shown in roentgenograms made of the stomach during the phase of diastole of the gastric motor phenomenon and with the patient in the erect posture (Fig. 32). The sulcus is characteristically present in the sthenic and asthenic types of stomachs which have a normal tone of the muscularis propria. The sulcus is the long narrow indentation which projects from the lesser curvature into the barium column between the corpus and antrum of the stomach. During the phase of systole of the gastric motor phenomenon (Fig. 31), the sulcus varies in depth and form because at this time the sulcus corresponds to the peristaltic contracting ring in this segment of the stomach. Although, during a gastric cycle, the indentation in the barium column changes its position, this change in position is only a change in the angle of inclination to a fixed point on the lesser curvature, as the base of the sulcus progresses so slightly that it corresponds to a limited area, namely, the *apex of the recedent angle* which the surgeon and anatomist observe on the outside of the stomach, that is, the *incisura angularis.* The *sulcus angularis* observed in the roentgenograms is produced by the *plica angularis,* a long muco-membranous fold which projects into the lumen of the stomach.

The length of the base of the contraction, in the longitudinal axis of the stomach, or the thickness of the apron-like fold which projects into the lumen of the stomach, is very constant in different cases (Fig. 96, Nos. 1-6). It is about 0.5 cm. from the proximal surface at the base directly across to the distal surface of the fold at its base. Within this space of 0.5 cm. across the base of the sulcus there is insufficient room for a reduplication of all the coats of the stomach, and only sufficient space for a reduplication of the mucosa and muscularis mucosæ together with a core of submucosa. This indicates that the peristaltic contraction of the sulcus angularis is the function of the mucularis mucosæ and not the muscularis propria. In Figure 34 we have illustrated the increase in thickness of the muscularis mucosæ which occurs at the tip of the plica angularis during peristaltic contraction. This increase in thickness of the muscle layer is directly reflected in the sulcus angularis in the roentgenogram as a roundish swelling or bulb-like form near the tip of the sulcus (Figs. 31, 51, and 96). The depth of the contraction or of the apron-like fold itself, that is, the distance from its base to its tip,

varies greatly in different cases (Fig. 96, Nos. 1-6), and in the same case in different postures of the patient and with different degrees of gastric distention (Fig. 96, Nos. 7-9).

The sulcus angularis is an extremely constant roentgenologic landmark and pathologic changes in this region of the stomach are directly shown by changes in contour and volume of the sulcus. Small, superficial ulcers which involve in depth only the mucosa or the mucosa and the superficial layer of the submucosa, appear in profile as small excavations in either the proximal or distal surface of the sulcus,—a protrusion of barium into the space of the sulcus which appears as if a mouse had nibbled a small hole into one surface of the sandwich (Figs. 97-100). These small ulcers are surrounded by such a small area of induration that it does not interfere with the gastric peristalsis, and as the sulcus shifts position with the progress of the peristaltic wave, the small excavation also shifts position in relation to the sulcus. At one phase the excavation may be in the proximal surface of the sulcus, and at another phase the excavation may be in the tip of the sulcus or even in the distal surface of the sulcus. When this occurs we speak of the crater of the ulcer as "riding with the wave of gastric peristalsis" (Figs. 97-100).

Larger areas of induration, either malignant or non-malignant, increase the width and shorten the length of the plica angularis and produce similar changes in appearance of the sulcus angularis (Fig. 101). When the induration is sufficiently large the fold, and correspondingly the sulcus, is entirely obliterated, and the absence of this characteristic finding is in itself of great significance (Fig. 102), but this constitutes the third finding.

Pyloric Valve.—The lumen of the stomach is partly separated from the lumen of the cap during most of the phases of the gastric cycle by a space about 0.5 of a centimeter. This space is universally recognized by radiologists and may be termed the "pyloric valve," "pyloric sphincter," or even "pylorus." We believe that "pyloric valve" is the preferable and more accurate term. Roentgenologically, it is so definite in its character that it has become a monumental landmark for roentgenologists and they use it as a point from which to take measurements, that is, they will state that an ulcer is so many millimeters beyond the valve, or so many centimeters proximal to the valve. Although this finding is very well known to roentgenologists, it is practically unknown to anatomists and surgeons. What they term the "pyloric sphincter" is the abrupt distal end of the fan-shaped muscle that is located at or near the base of the valve. The valve itself (Fig. 52), however, is composed only of a double layer of mucosa, muscularis mucosæ, and a core of submucosa. It does not contain the regular circular muscular coat (muscularis propria). Therefore, the roentgenologic appearance, measurements, and character of this fold should come, strictly speaking, under the heading of this section.

When the cap and distal part of the antrum of the stomach are distended and the pyloric valve is viewed accurately in profile, the valve appears as a space between the cap and stomach about 0.5 of a centimeter wide which does not contain barium. Centrally located in this space is a small column of barium in the lumen of the valve and connecting the barium column in

the stomach and cap. The appearance of the normal pyloric valve in relation to the normal stomach and cap is illustrated in Figure 37. The margins of the valve are smooth and clear-cut and the lumen of the valve is centric to the lumen of both the cap and the antrum.

The lesser curvature side of the pyloric valve is not an infrequent site of benign ulcers, and the ulcer may involve either the proximal or distal surface of the valve. The structure of both the distal and proximal sides of the valve is gastric in its characteristics and for this reason these ulcers should all be considered as gastric ulcers. When the ulcer involves only the mucosa and there is a very slight inflammatory reaction and induration, the roentgen evidence consists of a slight thickening of one side of the valve (almost without exception the lesser curvature side), together with the projection beyond the main barium column of the barium filling the small crater of the ulcer (Fig. 103). Around large ulcers the induration extends into the wall of both the stomach and cap, and the lesser curvature side of the valve is obliterated (Fig. 104). The induration of the wall of the stomach and cap flattens the contour of this region so that the lesser curvature side of the valve and the adjacent parts of the stomach and cap form a straight or slightly curved surface. As the greater curvature side of this region has retained its normal pliability the lumen of the valve is found to be eccentric to the lumen of both the cap and the stomach (Fig. 104). The induration around still larger ulcers may completely encircle the stomach and cap in the region of the valve (Fig. 105).

When ulcers of either the cap or the stomach lie adjacent to the pyloric valve, the induration may extend across the valve, producing a flattening of the contour and obliteration of one side of the valve (Fig. 106). The differentiation between ulcers of the valve proper and those which lie adjacent to the valve is determined by the location of the crater when this can be visualized, and otherwise by determining whether or not the valve lies at the center of the area of induration. Following healing of an ulcer a flattening of one side of the valve, with eccentricity of the lumen of the valve, may remain as a residual change (Figs. 107 and 108).

Malignant tumors of the stomach do not extend through the wall of the stomach beyond the valve to involve the wall of the cap. This phenomenon is difficult to understand but is a finding which is frequently observed roentgenographically and which often serves to differentiate between a newgrowth and an induration secondary to ulcer or inflammation. Malignant growths which extend to the valve (Fig. 109) or develop adjacent to the valve (Fig. 110) obliterate the proximal lip of the valve because this part of the valve and adjacent gastric wall is rendered non-pliable and there can be no expansion of the involved part of the stomach. If the growth involves the entire circumference of the pyloric end of the stomach, the lumen of the valve remains centric to the lumen of the cap and also to the lumen of the non-dilated antrum (Figs. 109 and 111). When the growth involves only one side of the pyloric end of the stomach the lumen of the valve remains centric to the lumen of the cap, but is eccentric to the lumen of the antrum (Fig. 135). In all malignant growths extending to the gastric side of the pyloric

valve, the distal side of the valve remains normal in contour except occasionally for a slight bulging toward the lumen of the cap (Fig. 111). Many extensive newgrowths of the stomach extend close to the pyloric valve but do not involve a narrow zone of the pyloric canal adjacent to the pyloric valve (Figs. 112-114).

Small Intestine.—The second fundamental finding is observed in the small intestine at the ileocecal valve (Fig. 46), where the intestine is inserted in the side of the cecum in a manner resembling a striking cobra, the head of the cobra being pressed into the side of the cecum. The length and thickness of the leaves of the valve are significant in the problem of ileocecal incompetency, but whether or not this condition of ileocecal incompetency is of clinical significance is a most debatable question. Distortion or thickening of the ileocecal valve or a retraction of one lip of the valve may result either from adhesions associated with a diseased appendix or from pregnancy, and occasionally it is thickened by tuberculous infiltration.

The characteristic mucosal folds of the small intestine, the valvulæ conniventes or plicæ semilunaris, might logically be considered as special mucosal folds to be discussed under the second fundamental finding. When the small intestine is distended, they are viewed on edge in the same manner in which one views the plica angularis, the pyloric valve, and the segmental rings of the colon. The small sulci, which the valvulæ conniventes form in the barium mold of the lumen of the small intestine, are, however, such an inseparable part of the mucosal pattern that we have chosen to consider them under the fourth fundamental finding.

Colon.—The second fundamental finding is observed in the colon in both *Houston's valves* and in the *segmental folds or rings.* The thickness and appearance of Houston's valves, as observed with the barium clyster (Fig. 115), is very similar to the finding observed in the sulcus angularis. These valves may be obliterated or deformed by malignant infiltration or the inflammatory process associated with infected diverticula that occur in the rectosigmoid region.

The *segmental folds* (Fig. 116) are so familiar that they are viewed with contemptuous indifference. Yet when one stops to analyze the fold and divide it into a base, stalk, bulb, and tip, and to study the relation of the thickness of each of these regions of the segmental fold, and to question the contents and function of the segmental folds, the motor phenomenon becomes of more than passing interest. The segmental folds in the colon are comparable with the plica angularis of the stomach and the plicæ circularis in the small intestine. They increase the mucosal surface of the colon and incarcerate fecal matter between them, and, while it is collected between the segments, water is absorbed from it so that it becomes more or less solid. In many herbivorous animals—in sheep, for example—fecal matter becomes so solidified between these folds that the latter retain the typical sheep dung shape. Occasionally, similar scybalous masses are observed in human beings: when they do occur it is evident that they have been formed in these pockets between the segmental rings. These folds when carefully scrutinized increase the

scope of radiological exploration of the mucosa of the colon. Too often are these mucosal folds passed without a careful consideration of both their proximal and distal surfaces. The significance of these folds as an aid to X-ray diagnosis is appreciated when one compares an X-ray film with a specially prepared surgical specimen of the colon (Fig. 60).

The anatomists who have written and edited the standard text-books on anatomy have universally stated that the exterior of the colon shows a sacculated condition which is characteristic of the colon. "Between the sacculations are semilunar folds (plicæ semilunaris coli), which involve the entire thickness of the intestinal wall, forming crescentic ridges of the mucosa which project into the lumen" *(Morris)*. "The exterior of the colon shows the sacculated condition, but there are no folds or valvulæ conniventes like those of the small intestine, . . . valvulæ conniventes are also wanting, although there are projections into the large gut involving all or part of the coats internal to the serous tunic" *(Piersol)*. The usual conception of the cause of formation of these sacculations is that the "sacculations (haustra) are produced by the gut having to adapt its length to three shorter bands (tæniæ coli) which run the course of the intestine" *(Morris)*.

The anatomical descriptions are quite logical as applied to the relaxed gut found at postmortem and in the anatomical cadaver used for dissection. It is impossible, however, to attempt an explanation of findings observed roentgenologically in the living subject by data obtained from such specimens. Here again, as in the stomach, surgical specimens which are preserved immediately after removal and in such a manner that their form and distention are similar to those observed in the living subject, are necessary for comparative study.

Figure 60 is a photograph (2 × magnification) of one-half of a surgical specimen prepared in such a manner, the specimen having been cut longitudinally near the lines of attachment of the mesentery and the epiploic fat pads. Projecting into the lumen of the gut are numerous folds which are directly comparable in size and distribution with the segmental rings which are observed roentgenographically and which divide the colon into the sacculations or haustra which are so characteristic of the colon as observed roentgenographically. The illustration shows very clearly that the folds are not a reduplication of the entire thickness of the wall of the colon, as described by anatomists, but only a reduplication of the mucosa and muscularis mucosæ together with a core of the submucosa similar to the plica angularis of the stomach. Along the superior surface of the colon, as illustrated, there is an indentation of the muscularis propria (both the circular and longitudinal layers of muscle), and here the indentation falls directly between two of the folds which project into the lumen and does not enter into their formation. In only one area *(A)* does the muscularis propria enter into the formation of a fold which projects into the lumen of the gut, and the relations in this region deserve a more detailed description in that the findings of this type may give an explanation of some of the findings observed in the roentgenograms. The fold at *A* is much broader than all of the other folds shown in this section, and the mucosal surface of the fold has three eminences. The

center eminence is continuous with the more narrow fold which extends completely across the specimen and which is sectioned on the superior surface of the specimen. This narrow fold does not contain the muscularis propria. The indentation in the muscularis propria at *A* does not continue around the specimen but terminates a short distance from the cut edge of the specimen, as one can observe in the photograph. The two lateral eminences on the surface of this fold *(A)* also extend for only a short distance away from the cut edge of the specimen; in fact, only as far as the indentation of the muscularis propria. The findings illustrated in this photograph establish two facts: The first is that folds which include all of the coats of the colon are very considerably thicker than the folds which are only a reduplication of the mucosa and muscularis mucosæ with a core of submucosa; the second is that on top of a fold due to reduplication or indentation of the muscularis propria there may be several eminences which are foldings of only the mucosa and submucosa.

There is still another finding of note which may be observed in the fold at *A*. The apex of the indented muscularis propria is thinner than the adjacent muscularis propria along the side of the fold. If this fold were due to an active contraction of the muscularis propria, one would expect exactly the opposite relation of the thickness of the muscle. For illustration of this fact refer back to the diagrammatic drawings illustrating the thickening of the muscularis mucosæ in the apex of the sulcus angularis (Fig. 51), and the pyloric valve (Fig. 52). The muscle which is responsible for the formation of a contracting ring or fold must be thickest at the apex of the fold, as this is the maximum point of contraction of the muscle, and, therefore, the area of greatest bulk or thickness of the muscle.

While studying this illustration one should note also that the thickness of the submucosa is very variable. At *A* the mucosa is very thick under all three of the mucosal eminences. This is also the case in one of the shallow folds on the superior surface. In the deeper folds the mucosa is thin in the stalk of the fold, but definitely increased in amount in the tip of the fold. Variations in the bulk of the submucosa in relation to the folds were undoubtedly the basis of part of the formation of Forssell's theory as to the mechanism of formation of the mucosal folds in general.

In specimens of the colon which we have preserved in a similar manner, we have observed sacculations of the colon which have been separated by folds taking in the entire thickness of the wall of the gut and entirely similar to the findings described in the text-books on anatomy. This type of fold is usually observed when the colon is considerably more dilated than is the specimen illustrated in Figure 60. The muscularis propria at the apex of these folds was never thickened but ended in a point. On the outside of the gut the line of indentation was usually marked by blood vessels encircling the gut or by subperitoneal fat accumulations. It is probable that many of these folds of this type are produced by dilatation of the gut around relatively fixed lines in the external part of the wall of the gut.

In order to determine just what parts of the wall of the gut may be

present in folds which produce the sulci observed in the roentgenograms, it was necessary to establish the actual thickness of the various coats. Under normal conditions in the living subject the coats of the colon are much thicker than the coats as observed in the preserved specimen. The thickness as determined in specimens which have been preserved in formalin for several days may, therefore, be accepted as the minimum thickness which could be present under like degrees of distention of the gut during life. The mucosa of the colon varies from 0.25 cm. to 0.5 cm. in thickness. The submucosa is variable and may be minimal in amount, or in the base of a low fold or the tip of a high fold may reach 0.5 cm. in thickness. The muscularis propria has a minimal thickness of 0.5 centimeter. The thickness of the coats as measured in the fresh specimen is greater than these figures, so that in constructing the colonic wall around the roentgenographic outline of the lumen of the gut we must make the thickness of the coats of the wall at the minimum the thickness of the figures given, and actually they should be made thicker in order to compensate for the contraction which takes place in the hardened specimen.

In Figure 117 we have traced the outlines and diagrammatically represented the lumen and thickness of the coats of the colon shown in Figure 60. The diagram has then been reduced to the actual size of the specimen. This diagrammatic representation of the actual specimen will, therefore, serve as a model of the actual condition present, for comparison with a theoretically constructed wall around the lumen as observed roentgenographically.

At first thought the motor phenomenon of the colon appears to be a simple process, but an analysis of the various findings observed roentgenographically and an attempt to explain these findings in terms of motor functions reveal that the contractions of the various muscle elements in the wall of the colon constitute a complicated process. The mere act of constructing the colonic wall around the lumen of the gut (as observed in the roentgenogram) reveals that there is not sufficient space within the sulci produced by the segmental rings for all of the coats of the colon to be present. Figures 118-123 are tracings of several colons, showing the type and contour of various segmental rings which we have observed. Around the contour of the lumen we have diagrammatically constructed the wall of the colon.

These diagrams show clearly that within these sulci there is only sufficient space for a reduplication of the mucosa and muscularis mucosæ, together with a core of the submucosa. Whether or not the muscularis propria may be dipped into the base of the fold by a pull through the submucosa as illustrated in Figure 60 is immaterial, since this would be only a passive change produced by forces extraneous to the muscularis propria and not an actual contraction of the muscularis propria itself.

The appearance of the wall of the gut theoretically constructed in this manner is directly comparable to the actual tracing of the wall of the colon specimen (Fig. 117). The folds are of the same type and the same composition. Figures 118-123 are tracings of segmental rings which were selected because their outlines were clearly discernible and could be traced

without guessing at the margin of the lumen of the gut. These tracings are from roentgenograms made of the colon after administration of a barium enema. One will immediately notice that the segmental folds vary greatly in their form and depth.

1. Short fold (Figs. 121 and 123).
2. Deep fold with narrow tip (Fig. 120).
3. Fold with bulbous tip (Fig. 121).
4. Ring with flattened tip and projection both distally and proximally (Fig. 122).
5. Ring with projection only proximally (Fig. 122).
6. Ring with projection only distally (Fig. 121).
7. Ring budding off of base of deeper fold (Fig. 118).
8. Double fold (Fig. 119).

In roentgenograms made of the colon during the passage or, rather, retention of the barium meal one may observe the same type of segmented rings shown in Figures 118-123 and Figure 116-*C*. There is, however, a definite tendency for the segmental rings to be broadened as shown in Figure 116, *A* and *B*. Broad rings of segmental contraction of this type show the possibility but not probability of the other coats of the muscularis propria entering into the formation of the folds.

A localized increase in tone or partial contraction of the muscularis propria we believe is more likely to account for the appearance illustrated in Figure 123, a finding which is not uncommonly found in a local region when the colon is filled with a barium enema. A similar finding is present in the middle of the transverse colon in Figure 116-*C*.

The effect upon the segmental rings of the extensive waves of contraction (the waves which Case has described) which move forward a large amount of the contents of the colon gives us a great deal of information regarding the nature of the segmental rings. These extensive waves of contraction begin in the ascending colon or in the region of the hepatic flexure. The contraction may extend for variable distances, to the middle of the transverse colon or into the descending colon. From the evidence which we have assembled, the relaxation of the contracted gut is in the reverse direction from which the contraction occurred. For a long time we have desired to study this phenomenon by roentgenocinematography, but as yet have not gotten to it. These waves of contraction are infrequent in occurrence and cannot be accurately anticipated. However, during the making of serial roentgenograms of the colon we have recorded the appearance of the colon in local regions before, during, and after this phenomenon has occurred, and from these records we have obtained much valuable information and are able to state that the following changes may occur in the colon:

1. When an extensive contraction of the muscularis propria occurs the segmental rings are not completely obliterated. As soon as the most intense force of the contraction is spent, the segmental rings can be recognized as flattened segments which give a grossly serrated appearance to the margin of the contracted gut (Fig. 124 and Fig. 116-*D*). Before we recognized

that these segmental folds remained as definite formations when the colon was contracted by the muscularis propria, we had been greatly puzzled by this gross serration of the lumen of the contracted gut. It is a familiar finding in practically all roentgenograms made of the colon after evacuation of a barium enema.

This phenomenon is shown characteristically in Figure 126, which is a tracing of two roentgenograms from a series of roentgenograms made of the proximal part of the colon while filled with a barium enema. The patient is lying prone in the right oblique position so that there is no confusion or overlapping of the shadows of the colon from the hepatic flexure to near the middle of the transverse colon. The solid line is a tracing of the outline of the colon as shown in Film No. 5 of the series. At this time the colon was moderately distended and the segmental rings which divide the first part of the transverse colon into sacculations or haustra are shown distinctly in profile. The outline of the colon is not distorted by longitudinal trisection of the colon by the longitudinal bands.

The interrupted line is a tracing of the outline of the colon as shown in Film No. 9 of the series. The outline only of the colon is shown, the intrinsic mucosal markings or pattern not being included. At this time there was an extensive contraction which extended from the cecocolic tract to past the middle of the transverse colon. The shortening of the colon which takes place when this type of contraction occurs is shown distinctly in the shortening of the ascending colon, with depression of the hepatic flexure and deviation of the cecum, and, also, in a shortening of the transverse colon which brings into view segmental folds not seen in Film No. 5, and pulls the hepatic flexure anteriorly. For identification we have numbered the segmental folds on both the inferior and superior surfaces of the transverse colon. Superimposition of the two tracings shows that every segmental fold observed in Film No. 5 may be identified as a flattened-out, broader fold in Film No. 9. The relation of the folds to each other is the same when the colon is partially distended and when it is contracted. This finding shows that the muscle element producing the segmental folds is not the same muscle that produces the more general contraction and the mass movements of the colon.

2. The independence of the segmental folds from contraction of the muscularis propria is further shown by the fact that a long segment of the colon may temporarily contract without disturbing the arrangement of the segmental folds. Figure 127 is a tracing of three roentgenograms from a series of five which were made of the transverse colon while the colon was filled with a barium enema. This series of films was made with an interval of a minute following each roentgenogram and the experiment was made with the definite object of determining what changes occurred in the segmental folds during a short interval of time. We were fortunate in accidentally recording on Film No. 2 a mass contraction which occurred and relaxed during the interval of three minutes between the making of Films No. 1 and No. 4. Film No. 2 was probably made at the height of contraction and at this time the proximal part of the colon was contracted and the

distal part of the transverse colon was markedly dilated. During this time the patient did not evacuate any of the barium clyster. The solid line is a tracing of the colon outline in Film No. 1, the dotted line is a tracing of Film No. 2, and the broken line is a tracing of Film No. 4. In the stage of contraction (dotted line) the imprint in the outline of the lumen of the flattened segmental folds is clearly shown. The most interesting finding, however, is the fact that the number and distribution of the segmental folds is absolutely identical in Films No. 1 and No. 4. This shows most clearly that a temporary extensive contraction of the muscularis propria may take place without obliteration of the segmental folds, and that following relaxation of the contraction and with the same distention of the gut the segmental folds will have identically the same form and distribution.

3. During a period of contraction of a long segment of the colon the contour of the gut does not remain constant, although the gross outline retains the same general form. Figure 128 is a tracing of two consecutive films from the same series, as was illustrated in Figure 126. A time interval of approximately 30 seconds elapsed between the making of these consecutive films. In this interval of time no change has taken place in the gross form of the outline of the colon, the indentations due to the segmental folds remaining present and changing only slightly in form. There are, however, many slight variations in the finer details of the outline. These changes may be due to varying degrees of tension in the muscularis propria.

4. At the actively contracting end of a long contraction causing a mass movement (Fig. 125, *x*) the mucosa and segmental folds are thrown forward ahead of the contraction wave, the appearance being similar to the bending of tall grass as it is swept by a gust of wind. This is entirely similar to the change in appearance of the valvulæ conniventes of the small intestine ahead of a broad wave of peristalsis.

From the preceding observations we can logically deduce that the segmental folds of the colon are a reduplication of the mucosa and muscularis mucosæ with a core of submucosa, and that they are similar to the sulcus angularis, pyloric valve of the stomach, and the valvulæ conniventes of the small intestine. Further, likewise, analogous to these other structures, we believe that the segmental folds of the colon are the product of an active contraction of the one continuous muscle layer included within them, that is, the muscularis mucosæ.

That the segmental folds may remain unchanged, even though extensive changes occur in the muscularis propria, has been illustrated in Figure 127. The question naturally arises as to what spontaneous changes do occur in these folds and whether they progress either distally or proximally in the long axis of the colon. As regards the second question, we do not have sufficient evidence as yet to establish whether or not there is any peristaltic action of the segmental folds. The first question is partially answered by a study of Figure 129, which is a group of four tracings of the outline of the distal part of the transverse colon as shown in four of a series of seven films made during a time interval of several minutes.

The segmental folds 1, 3, 4, 5, and 6 show a definite variation in form and 1 and 4 show a marked variation in depth. Fold 2 disappears and is replaced by two folds in a different location (*D* and *E*). At *A*, *A'*, *B*, and *C* there are shallow folds which are not constant and are differently situated in the several roentgenograms.

It is our opinion that these folds act functionally to break up into variable segments the fecal contents of the colon so that the mucosa is brought into contact with different, varying parts of the fecal material. We do not believe that they exert any function in moving the contents of the colon from one region to another.

THIRD FUNDAMENTAL FINDING

(Pliability of the mucosa to peristalsis)

The third fundamental finding is the pliability of the mucosa to peristalsis. This finding is comparable with the waves of the sea as they are interrupted by floating objects, particularly by flat cakes of ice (Fig. 68)—hard, malignant or non-malignant areas, like flat cakes of ice, interfere with the gastro-intestinal peristalsis. This finding is the most delicate of the four and it requires serial roentgenography for its application to early lesions. Use of this finding necessitates the presence of peristaltic contractions which are repeated at sufficiently frequent intervals so that roentgenographic records may be made which will show whether peristaltic contractions pass through a certain section of the gut in a normal manner, or whether they are obstructed by an area of infiltration which has rendered the wall of the gut non-pliable. Reversely considered, the presence of normal peristaltic contractions is of equal importance in that it rules out the presence of infiltration sufficiently deep to interfere with the contracting muscle.

Esophagus.—Under ordinary conditions of examination, particularly with the patient in the erect posture, peristaltic contractions of the esophagus are infrequent and not prominent. Examination of the patient in the recumbent position, with the hips elevated, will usually elicit peristalsis in the esophagus, as the barium bolus must then be forced up an inclined plane. Likewise, the presence of a partial obstruction will often call forth an abnormal number of peristaltic contractions.

Figure 130 shows an unusual finding in the esophagus, which is a physiological reaction to an inconstant spasm in the region of the cardia. The peristaltic contractions, as is usual, are inconstant in depth and arrangement. The slightly dilated esophagus shows the impressions of the adjacent organs so distinctly that the pliability of the wall of the esophagus as shown in the progress of the peristaltic contractions is a valuable aid in ruling out the presence of a newgrowth. This was highly essential in this case because the clinical history was indicative of a newgrowth, that is, difficulty in swallowing and a loss of 60 pounds weight in eight months.

Figure 72 shows the opposite application of this finding. There is an extremely small carcinoma involving the posterior wall of the esophagus, and the growth is not sufficiently large to produce the usual characteristic de-

formity of the contour of the esophagus. The non-pliability of the wall in this area, as shown by the fact that the peristaltic contractions do not pass through this region, establishes a positive diagnosis of a lesion infiltrating the wall of the esophagus. The roentgenographic diagnosis of carcinoma was corroborated by esophagoscopy.

Stomach.—The third fundamental roentgenologic finding is of greatest value in study of the stomach. In this organ the peristaltic contractions normally recur in definite and frequently repeated cycles. A series of roentgenograms made of the stomach within a short period of time will record the pliability of the gastric wall. By matching one film over another one can determine accurately the slightest variation in contour of the gastric wall as it reacts to the peristaltic contractions. Serial roentgenography in several positions and projections will show definitely whether the various surfaces of the gastric wall are pliable (Fig. 5), or whether the peristaltic contraction is obstructed by an area of infiltration, malignant (Fig. 131) or non-malignant (Fig. 132). An old but simple method of demonstrating the pliability of the gastric wall is shown in Figure 133. With this method, two or three exposures are made on the same film while the patient maintains his position and holds his breath. The exposures are made at intervals of from 2 to 4 seconds, and each exposure is one-half or one-third of the normal exposure.

The application of this method to very slight areas of induration is a most delicate procedure and serial roentgenography is essential to detect a lack of pliability in a small section of the gastric wall due to an early carcinoma. This finding is especially valuable in detecting the presence of a diffusely infiltrating cancer which involves the entire lesser curvature of the stomach without producing any gross deformity of its contour. This type of lesion frequently escapes detection because of the lack of characteristic deformity of contour, and yet the absence of peristalsis is strongly diagnostic.

Small shallow ulcers of the stomach which involve only the mucosa produce a local rigidity of the gastric wall, but this rigid area is so small that it does not disturb the pliability of the adjacent gastric wall. The ulcer, therefore, changes its position in relation to the peristaltic contractions as shown in Figures 97 and 100.

In the pyloric canal one observes a similar disturbance of contraction due to infiltration of the gastric wall. The relation is somewhat different in this region because the contraction of the pyloric canal is a progressive concentric contraction instead of a progressive peristaltic contraction. The small carcinoma shown in Figure 135 and which involves the lesser curvature side of the pyloric canal, was successfully diagnosed roentgenographically and the positive diagnosis of cancer was based on the constant lack of pliability in a local region of the lesser curvature side of the pyloric canal. A chronic spasm of the pyloric canal, which may produce a similar deformity, will always show a change in contour of the lumen of the pyloric canal because the pliability of the wall is not completely lost (Fig. 136).

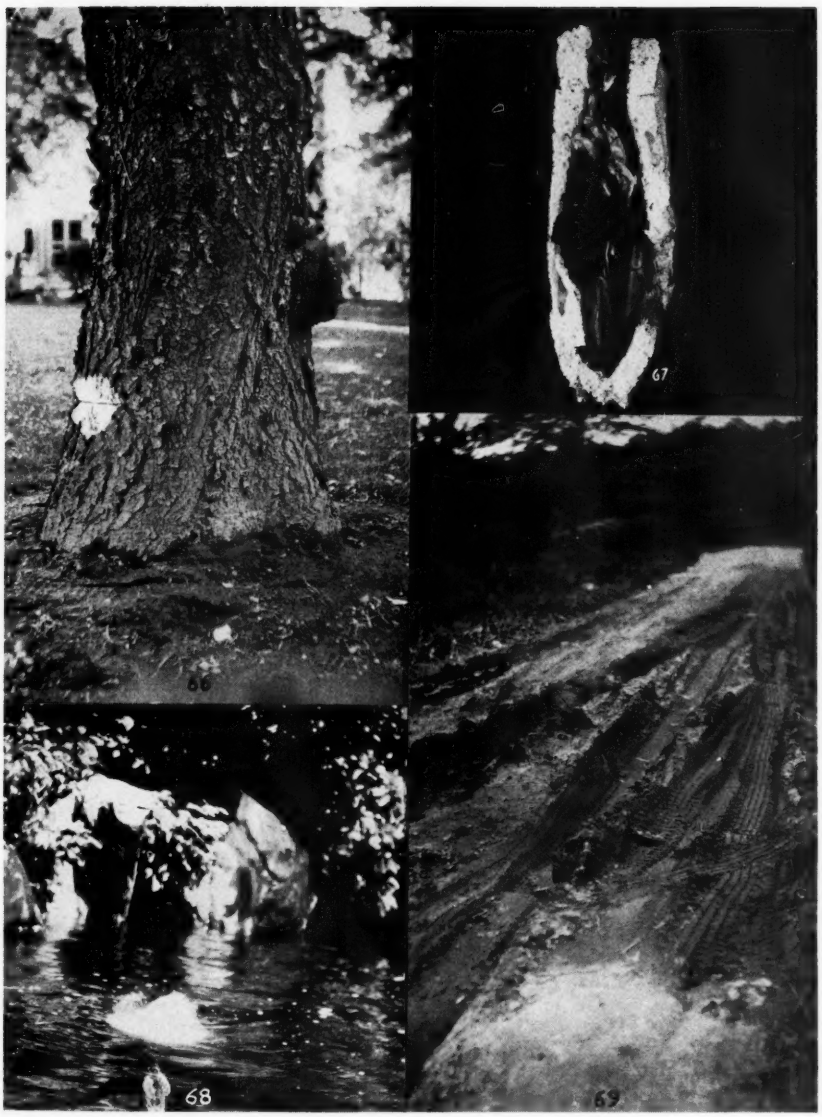


Fig. 66. The first fundamental finding may be likened to one walking around a tree, examining its bark and noticing whether it is smooth or rough, bulged as by a growth, or barked as by an ulcer.

Fig. 67. The second fundamental finding is well illustrated by a sandwich, that is, a double slice of bread is likened to the double layer of mucosa and the filling to the submucosa.

Fig. 68. The third fundamental finding is comparable with the waves of the sea as they are interrupted by floating objects, particularly by flat cakes of ice.

Fig. 69. The fourth fundamental finding is comparable with the ruts in an old dirt road in the country, partly filled with water and skimmed with ice; a simile not too familiar to the younger generation.

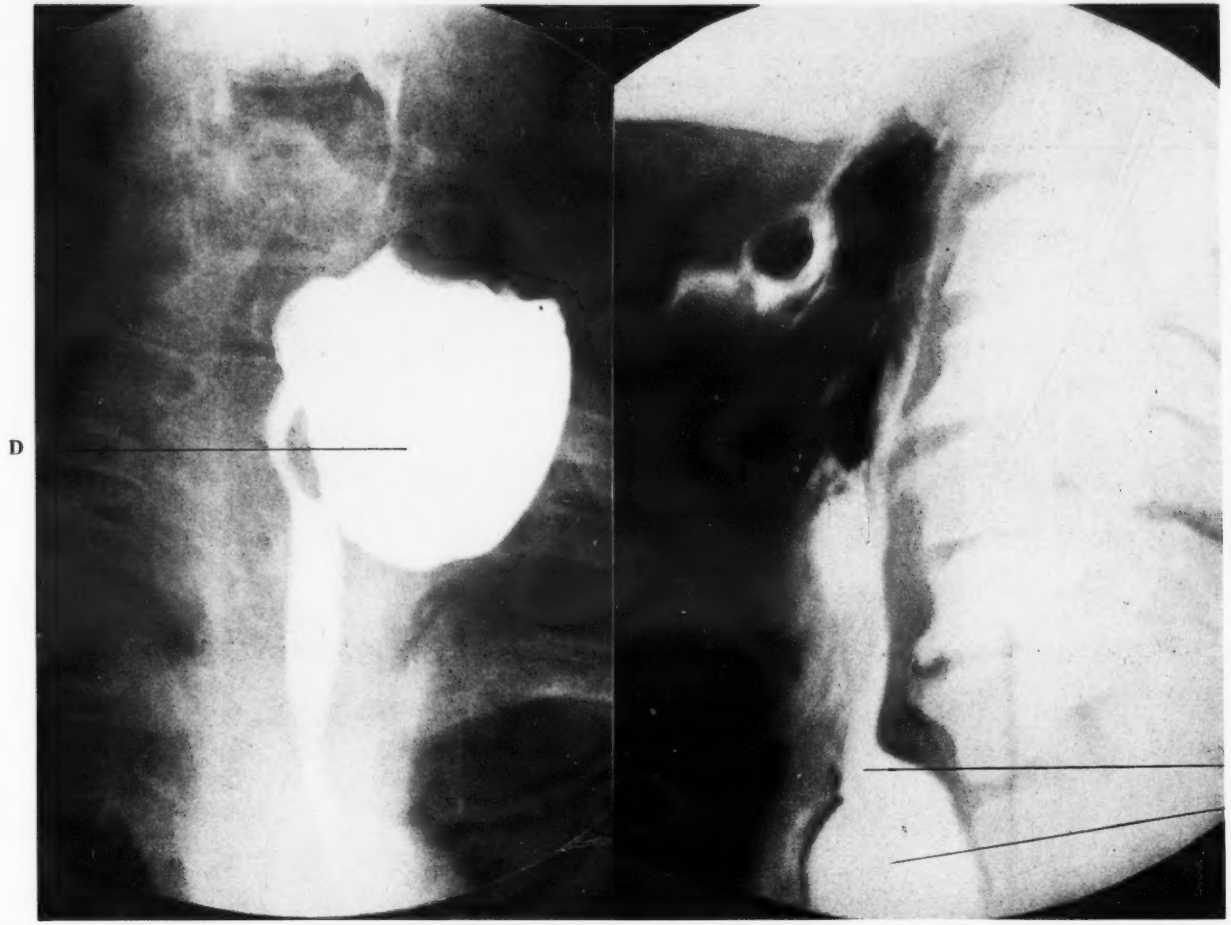


Fig. 70

Fig. 71

Roentgenograms made in the postero-anterior direction (Fig. 70), and the lateral direction (Fig. 71) show the alteration in contour of the esophagus produced by a large diverticulum (*D*), which protrudes outside of the normal line of the lumen of the esophagus. The manner in which the neck (*N*) of the diverticulum arises from the posterior side of the esophagus opposite the body of the seventh cervical vertebra is shown in Figure 71. The esophagus is displaced forward and to the right by the diverticulum.

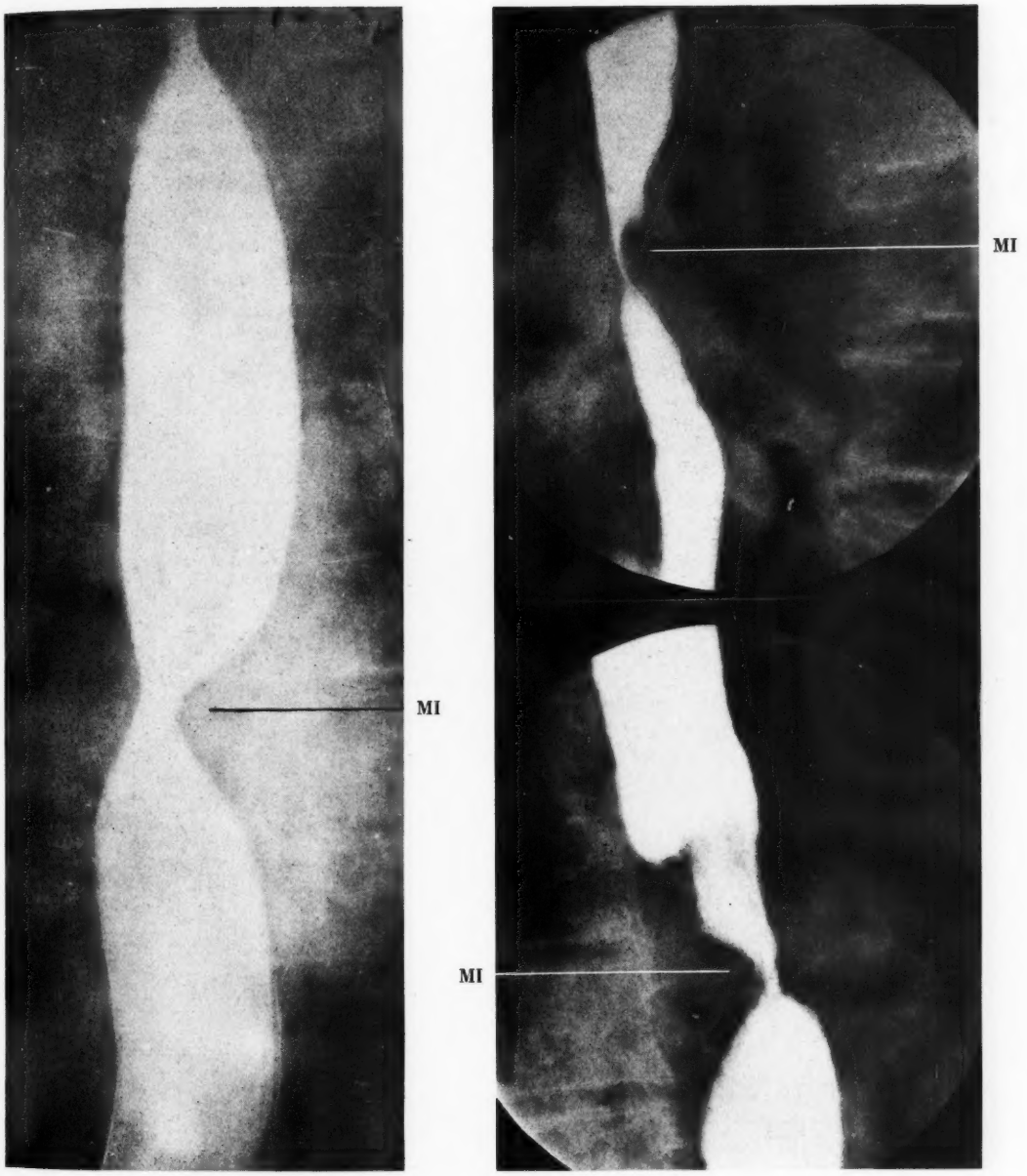


Fig. 72. Roentgenograms made of the esophagus in the anteroposterior and right and left oblique directions show a small area of malignant induration (*MI*) of the mucosa which involves only part of the circumference of the esophagus. The malignant induration projects into the lumen and displaces the barium, thus giving an alteration from the normal contour. This illustrates the first fundamental finding which enables one to detect a small pathologic lesion. The non-pliability of the wall of the esophagus in this area—third fundamental finding—was shown by the fact that the peristaltic contractions did not pass through this region.

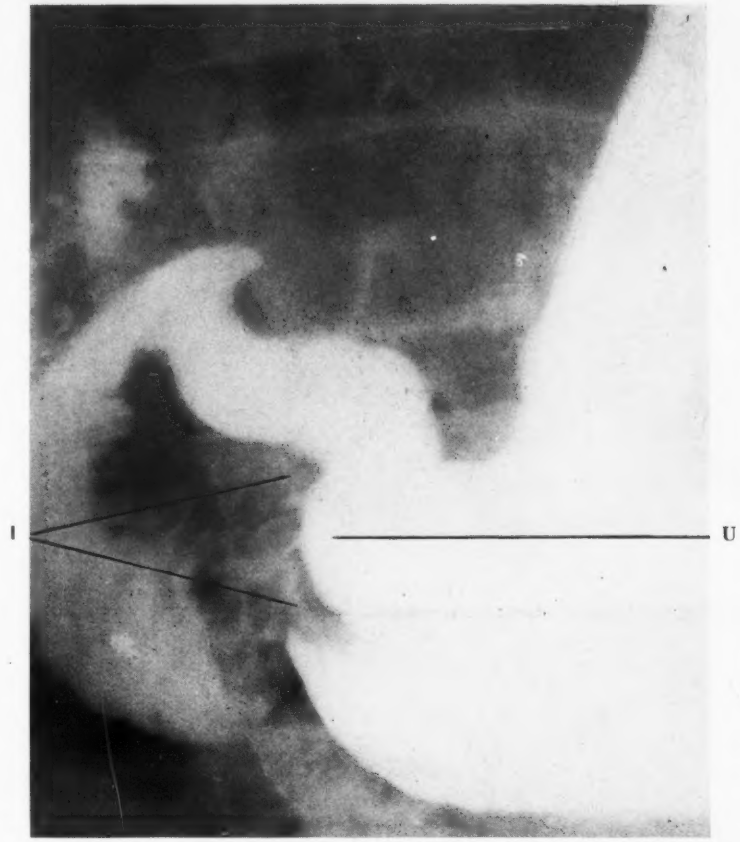


Fig. 73

Fig. 73. Roentgenogram in which a growth is observed to project from the greater curvature of the antrum into its lumen. The surface of the central portion of this growth has been destroyed, resulting in an ulcer (*U*). This figure illustrates the manner in which the induration (*I*) around a malignant ulcer projects into the lumen of the stomach. This is particularly well shown in Figure 75 which is a photograph of a longitudinal section of the surgical specimen of this same case.

Fig. 74

Fig. 74. Roentgenogram which shows a benign ulcer (*U*) on the lesser curvature side of the antrum. The barium in the crater protrudes beyond the contour of the adjacent gastric wall. Figure 76 is a photograph of a longitudinal section of a similar ulcer.

Fig. 75

Fig. 75. Photograph of a longitudinal section through the malignant growth of the stomach illustrated roentgenographically in Figure 73. This shows the manner in which ulcerating malignancies project into the lumen of the stomach.

Fig. 76

Fig. 76. Photograph of a longitudinal section through a gastric ulcer similar to the ulcer shown roentgenographically in Figure 74. The crater of this benign ulcer protrudes beyond the contour of the adjacent gastric wall.

C—crater: *M*—mucosa: *MP*—muscularis propria, broken by the ulcer in Figure 76; not broken but infiltrated with carcinoma and retracted in Figure 75: S^1—submucosa, infiltrated with carcinoma: S^2—submucosa, connective tissue wedge: *P*—peritoneum of serosal coat, no subperitoneal patch: *PP*—subperitoneal patch of connective tissue in intraperitoneal gastric triangle.

Fig. 78. Ulcer of the cap. The crater of the ulcer (*U*) protrudes beyond the margin of the lumen of a cap of otherwise normal appearance.

Fig. 79. Ulcer of the cap. The posterior surface of the cap is normal in contour except for the crater of an acute ulcer (*U*). The crater protrudes beyond the normal contour of the lumen. The expansion of the anterior wall of the cap (*AW*) is limited by recently formed peritoneal adhesions. This roentgenographic examination was made 4½ hours after the onset of symptoms.

Fig. 80

Fig. 81

Figs. 80 and 81 are roentgenograms which show the manner in which the crater of an ulcer (*U*) of the cap protrudes outside of the contour of a cap which is diminished in size locally by induration of the cap wall. *PF*—prepyloric fold.

Fig. 82

Fig. 83

Fig. 84

Fig. 85

Figs. 82-85 are roentgenograms which show alterations in the contour of the cap by changes which encroach upon the lumen. Fig. 82 shows an infolding of the entire thickness of the wall of the cap by a veil or band of adhesions. Fig. 83 shows the projection into the lumen of the cap caused by the induration around an ulcer. Fig. 84 shows the irregular deformity of the lumen of the cap caused by multiple bands of scar tissue. Fig. 85 shows the projection into the lumen caused by bands of scar tissue, and also shows the protusion beyond the normal contour of the dilated uninvolved portion of the cap proximal to an area of stenosis.

Fig. 86

Fig. 87

Fig. 88

Fig. 89

Figs. 86-89 are roentgenograms of four cases which show diverticula of the duodenum and the manner in which the diverticula protrude beyond the normal contour of the duodenum. Fig. 86. Four diverticula arising from the superior side of the transverse duodenum. Fig. 87. A diverticulum arising from the right side of the ascending duodenum. Fig. 88. A diverticulum arising from the left side of the descending duodenum adjacent to the papilla of Vater. Fig. 89. A large diverticulum arising from the superior side of the duodeno-jejunal flexure.

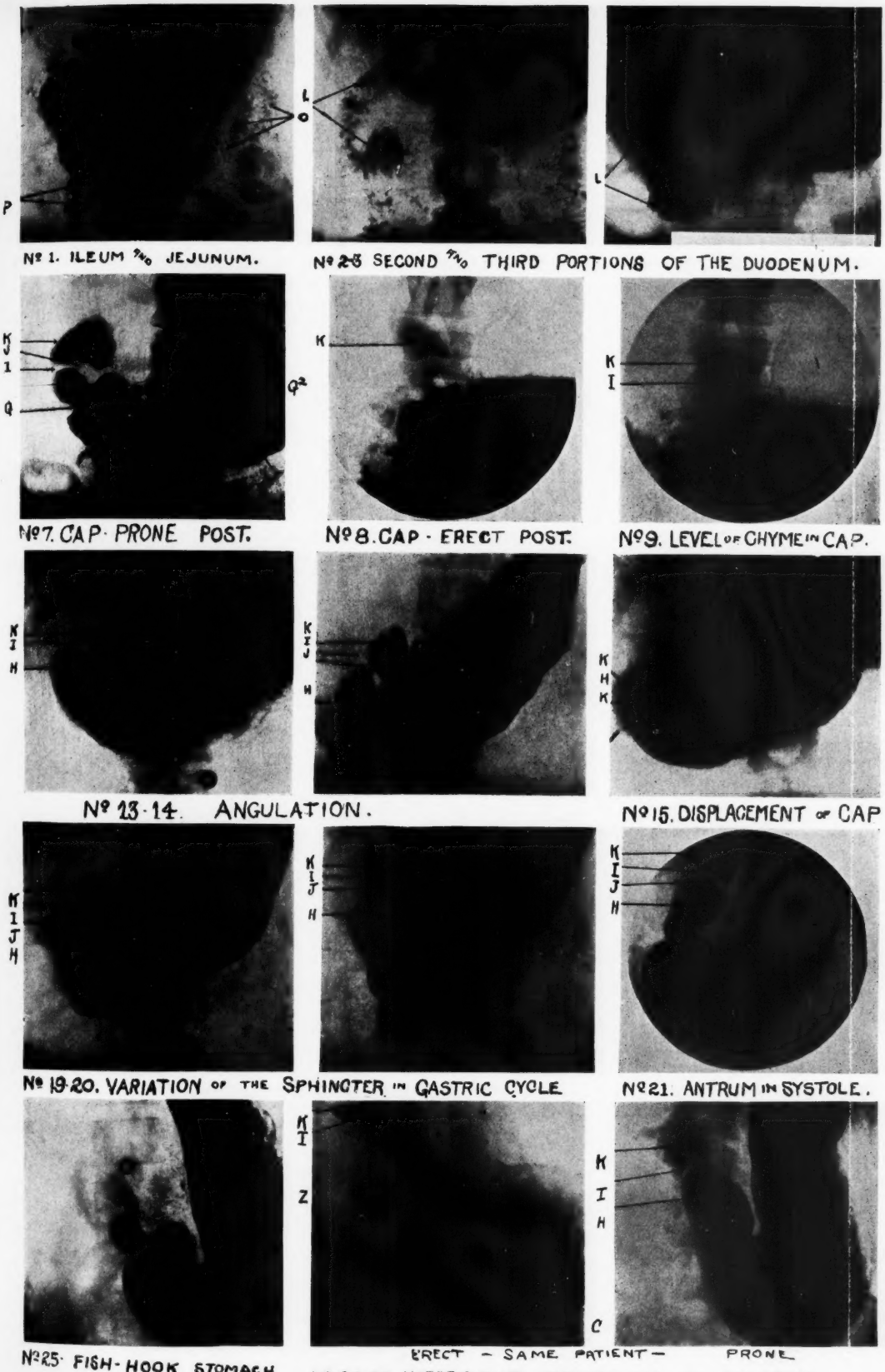
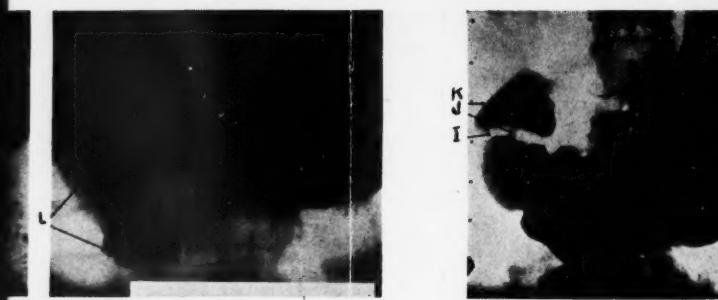
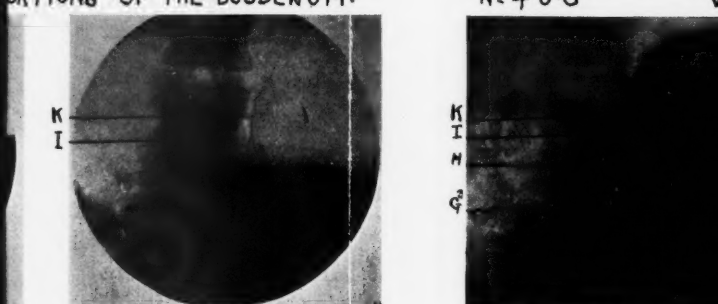


Fig. 77. "Radiographic study of the pylorus and duodenum." Th half-tone plate used to illustrate an article published in



ORTIONS OF THE DUODENUM.

Nº 4-5-6



Nº 9. LEVEL OF CHYME IN CAP.

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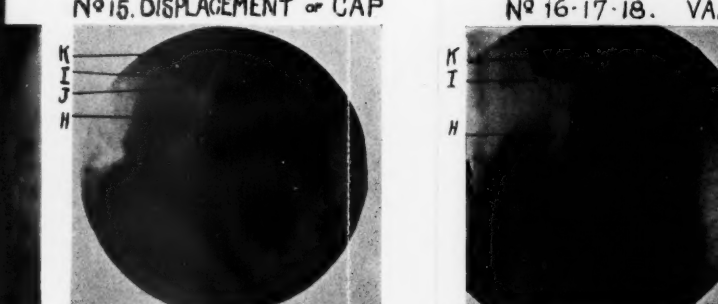
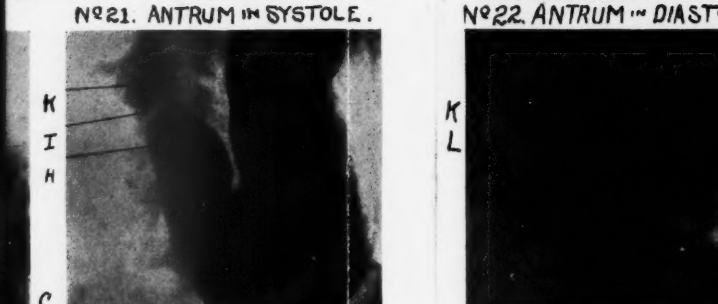
Nº 15. DISPLACEMENT OF CAP

Nº 16-17-18. VA



Nº 21. ANTRUM IN SYSTOLE.

Nº 22. ANTRUM IN DIAST



PATIENT— PRONE

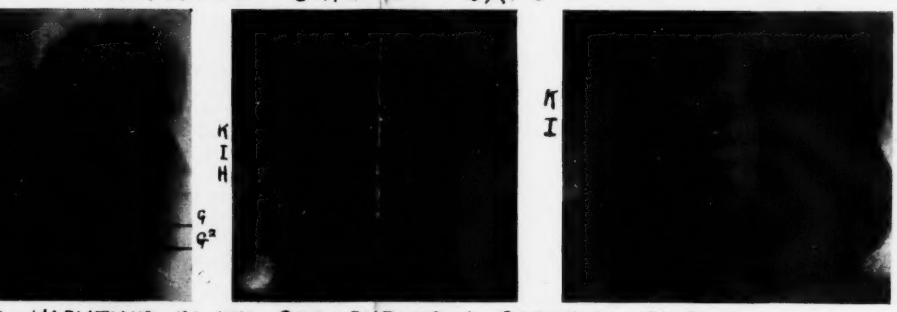
TUBE.

RISTALSIS OF PYLORUS.

Nº 28-29 30. ARTIFIC

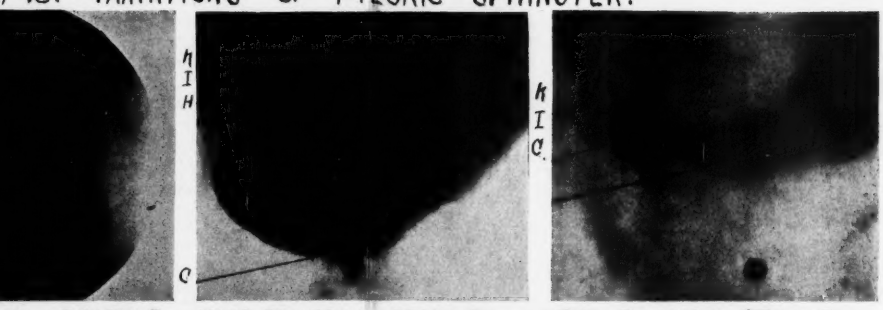
hic study of the pylorus and duodenum." This double page of illustrations w
plate used to illustrate an article published in the "Archives of the Roentgen

VARIOUS SHAPED "CAPS".

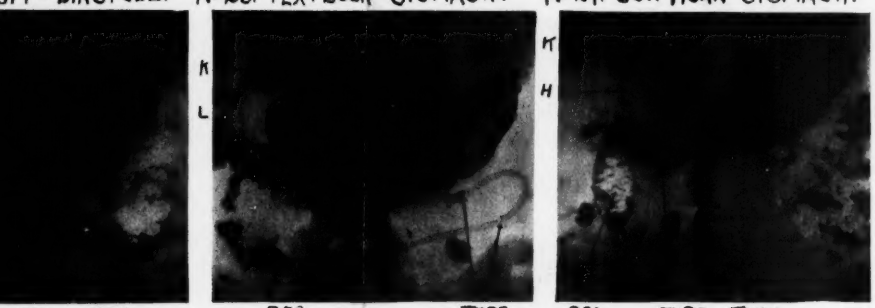


VARIATIONS IN THE CAP DURING A GASTRIC CYCLE.

7-18. VARIATIONS OF PYLORIC SPHINCTER.



UM IN DIASTOLE. No 23. TEXT-BOOK STOMACH. No 24. COW-HORN STOMACH.



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). ARTIFICIAL DILATATION OF THE DUODENUM.

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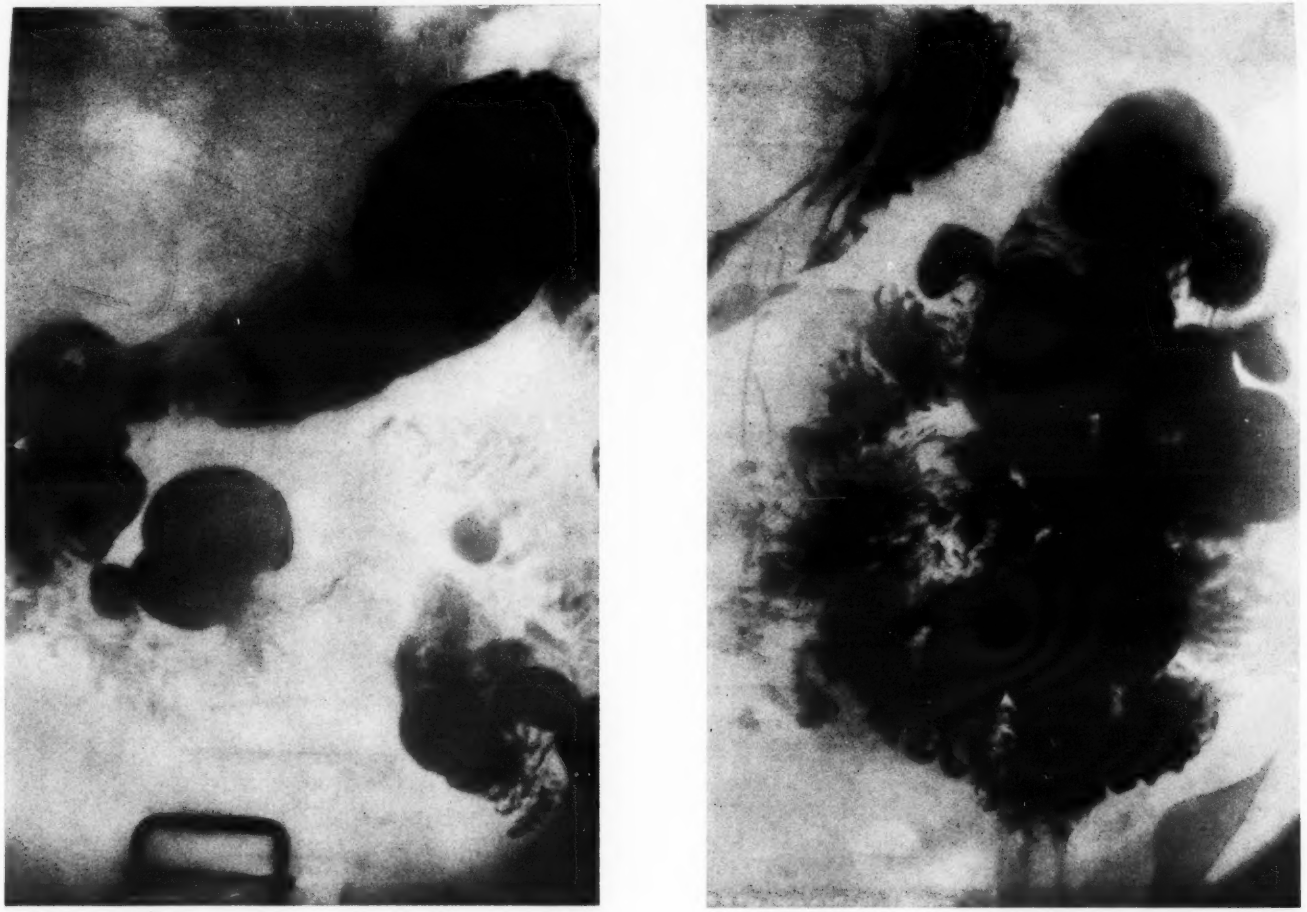
the Roentgen Ray," April, 1912.



A B

Fig. 90. Roentgenograms made one-half hour (*A*) and two hours (*B*) after ingestion of a barium meal which show multiple diverticula of the duodenum and the second and third groups of coils of the small intestine. The barium flows into the diverticula and the shadows of the diverticula protrude beyond the normal contour of the small intestine. On casual examination one might consider that the overlapping shadows of the diverticula as shown in *B* were due to a filled colon.

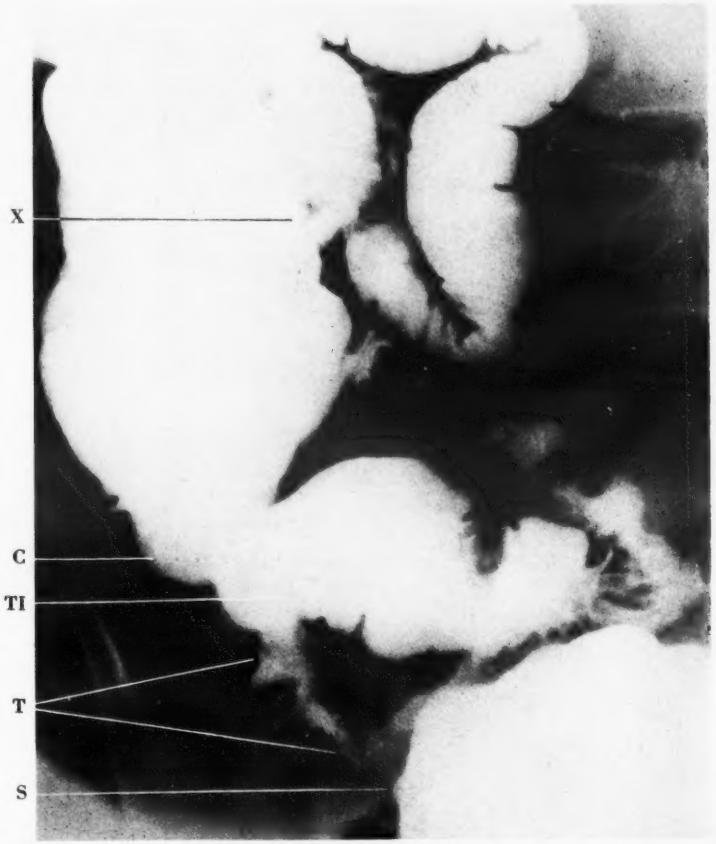


Fig 91. Tuberculosis of the small intestine. The terminal coil of the sixth group of coils is constricted by a tuberculoma (*T*). Diagnosis confirmed by operation. *TI*—dilated coil of terminal ileum: *C*—cecum: *X*—sixth group of coils displaced by adhesions: *S*—sigmoid.

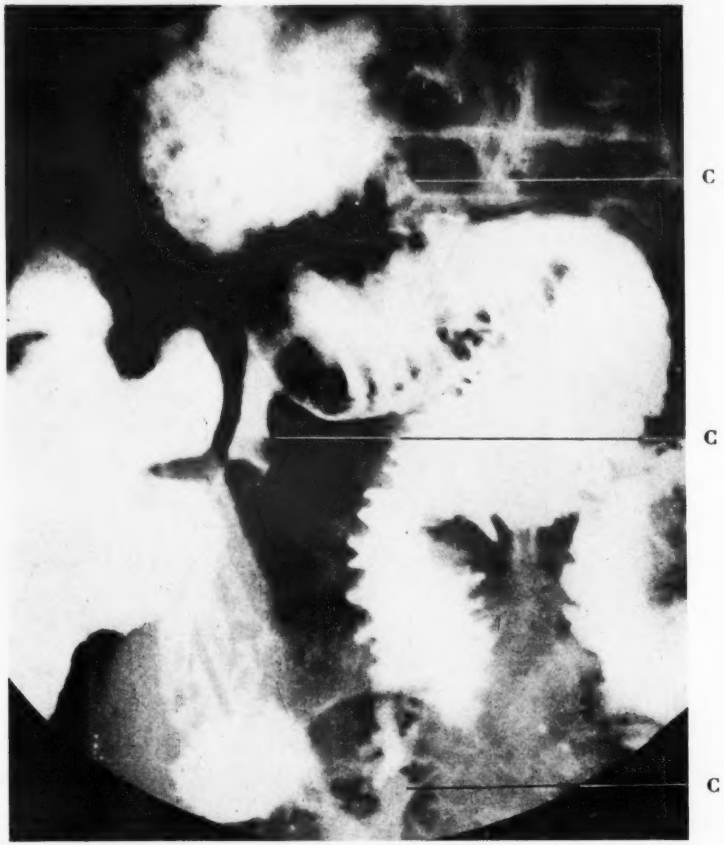


Fig. 92. Multiple areas of constriction (*C*) in the sixth group of coils of the small intestine caused by tuberculosis. (This roentgenogram is reproduced through the courtesy of the late Webster W. Belden.)

sixth group of coils displaced by adhesions; S—sigmoid.

Fig. 93

Fig. 94

Figs. 93 and 94 are roentgenograms which show the manner in which an adenocarcinoma of the cecum protrudes into the lumen of the gut. Fig. 93 shows displacement of the barium by the growth, and Fig. 94 shows the growth surrounded by air.

Fig. 95

Fig. 95. Roentgenogram which shows the manner in which diverticula of the descending and sigmoid colon protrude beyond the normal contour of the gut.

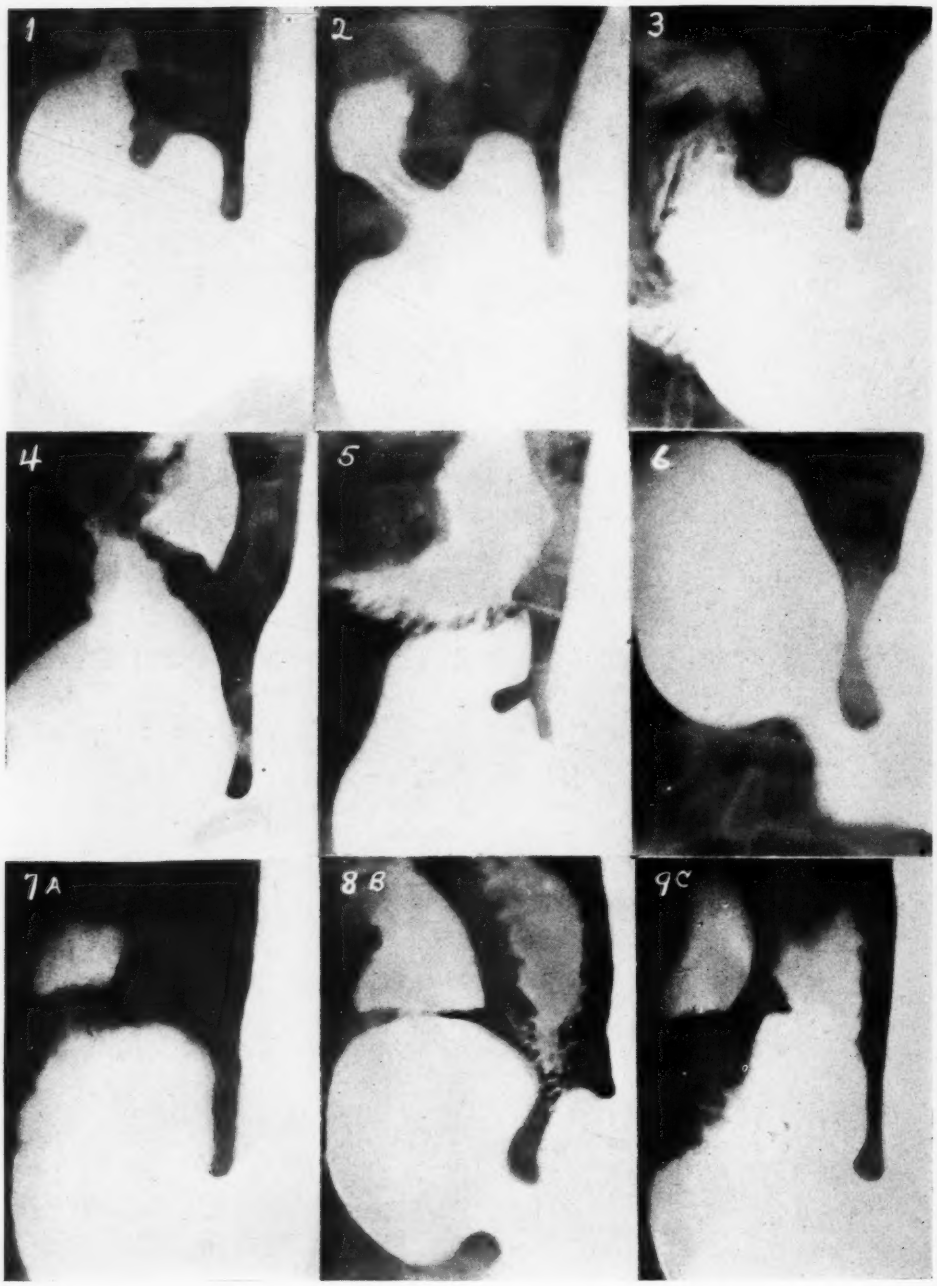


Fig. 96. Sulci angulares of several cases, and of different stages of the same case. 1, 2, 3, 4, 5, 6—types of sulci observed in different cases: 7, 8, 9—the sulcus of the same case at different stages of the cycle. *A*—diastole: *B*—systole: *C*—the pyloric canal closed.

Fig. 97

Fig. 98

Fig. 99

Fig. 100

Figs. 97-100 are four of a series of roentgenograms which show a small mucosal ulcer in the region of the sulcus angularis. There is not sufficient induration around the ulcer to interfere with peristalsis and as a result the crater of the ulcer rides with the wave. In Fig. 97 the crater is in the distal surface of the peristaltic wave at the sulcus. In the succeeding figures the peristaltic wave has moved pyloruswards and the crater is successively at the tip of the wave (Fig. 98), in the proximal surface of the wave (Fig. 99), and proximal to the wave (Fig. 100).

Fig. 101. Roentgenogram which shows a small submucosal ulcer in the proximal surface of the sulcus angularis. The induration around the ulcer has increased the width of the sulcus angularis.

Fig. 102. Roentgenogram which shows an ulcer in the region of the sulcus angularis which is sufficiently deep to involve the muscularis propria. The crater and the surrounding area of infiltration have obliterated the sulcus angularis.

Fig. 101. Roentgenogram which shows a small submucosal ulcer in the proximal surface of the sulcus angularis. The induration around the ulcer has increased the width of the sulcus angularis.

Fig. 102. Roentgenogram which shows an ulcer in the region of the sulcus angularis which is sufficiently deep to involve the muscularis propria. The crater and the surrounding area of infiltration have obliterated the sulcus angularis.

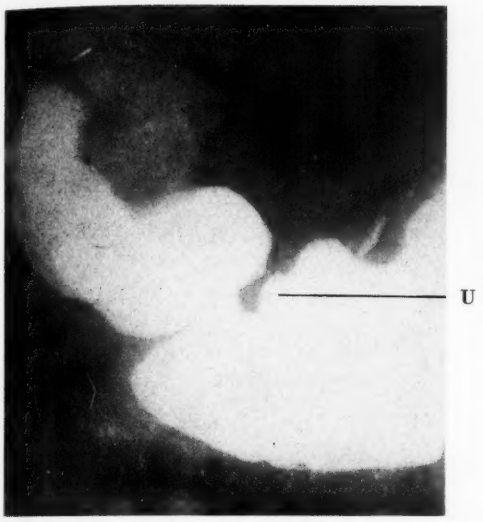


Fig. 103. Roentgenogram which shows a small shallow ulcer (*U*) involving the proximal surface of the lesser curvature side of the pyloric valve. The induration around the crater has thickened the lesser curvature side of the valve.

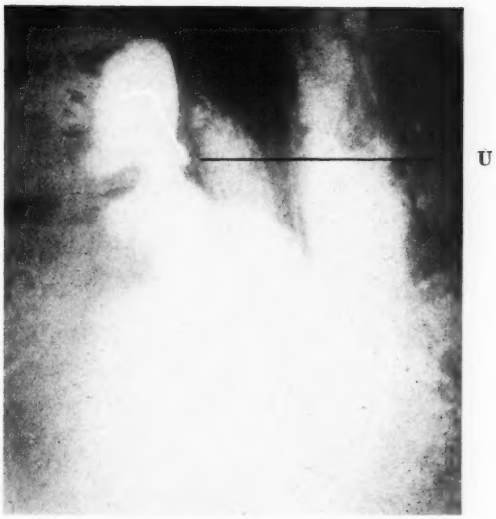


Fig. 104. Roentgenogram which shows an ulcer (*U*) in the middle of the pyloric valve. The induration extends into the wall of both the stomach and cap so that the lesser curvature side of the valve is obliterated and there is flattening of the contour of the adjacent parts of the stomach and cap. The residual deformity which was present after this ulcer was healed is shown in Figure 107.

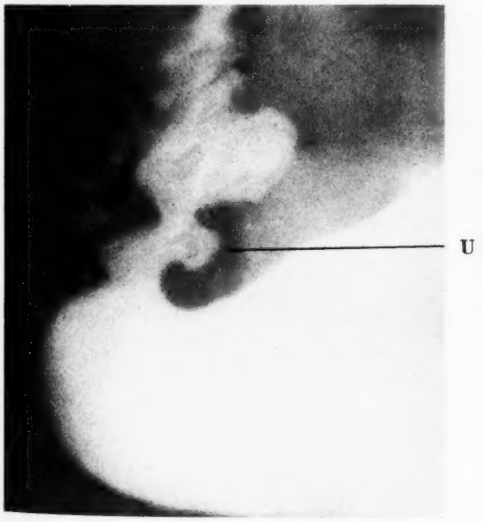


Fig. 105. Roentgenogram which shows a deep ulcer (*U*) in the pyloric valve. The induration completely encircles the stomach and cap in the region of the valve.

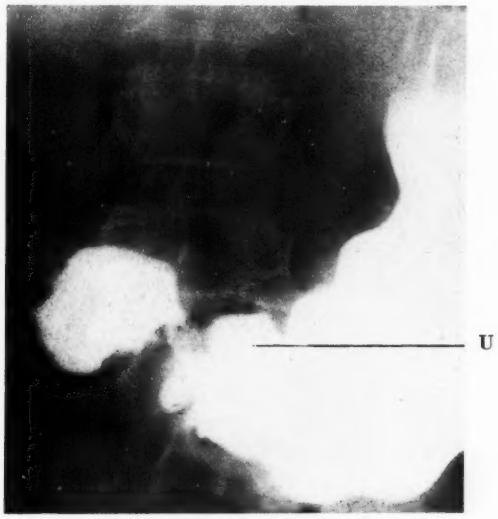


Fig. 106. Roentgenogram which shows the manner in which induration around an ulcer (*U*) of the antrum may extend across the pyloric valve and produce a flattening of the contour of one side of the valve and the adjacent part of the cap.

Fig. 107

Fig. 108

Figs. 107 and 108 are roentgenograms which show the flattening of the lesser curvature side of the pyloric valve and adjacent parts of the stomach and cap which remains after healing of a deep ulcer of the pyloric valve. Fig. 107 is the same case as shown in Figure 104 after an interval of 48 days.

Fig. 109. Roentgenogram which shows a funnel-shaped carcinoma of the antrum which extends to the pyloric valve. The contour of the cap side of the valve is normal and the lumen of the valve is centric to the lumen of the cap and the lumen of the constricted antrum.

Fig. 110. Roentgenogram which shows an annular carcinoma of the pyloric canal. The growth does not extend into the wall of the cap.

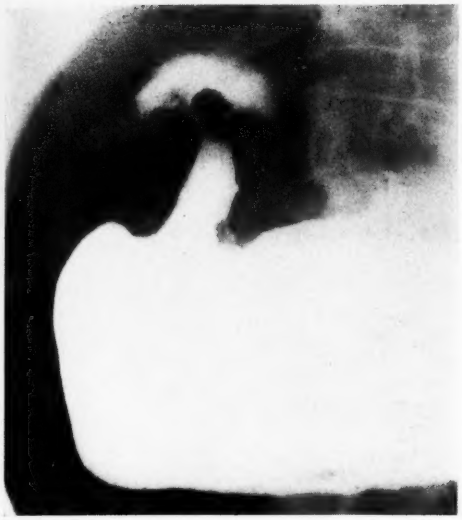


Fig. 111. Roentgenogram which shows an annular carcinoma of the antrum which has developed adjacent to the proximal side of the pyloric valve. The growth does not extend into the wall of the cap. At the base of the cap there is a small indentation where the valve protrudes slightly into the cap.

Fig. 112. Roentgenogram which shows an extensive carcinoma simplex involving practically all of the stomach except the portion adjacent to the pyloric valve.

Fig. 113

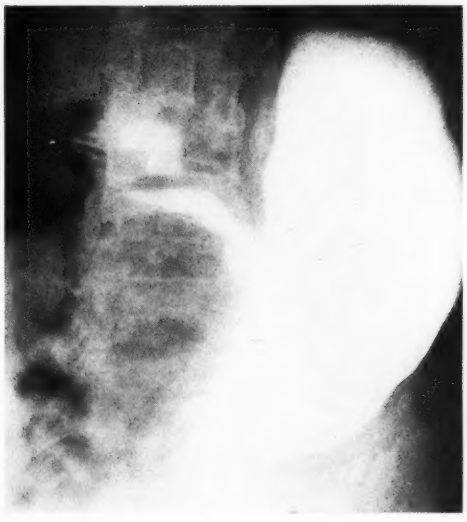


Fig. 114

Figs. 113 and 114 are roentgenograms made in the prone and erect postures which show a bulky adenocarcinoma involving the antrum of the stomach. The tumor extends close to the pyloric valve but does not involve it or extend into the wall of the cap.

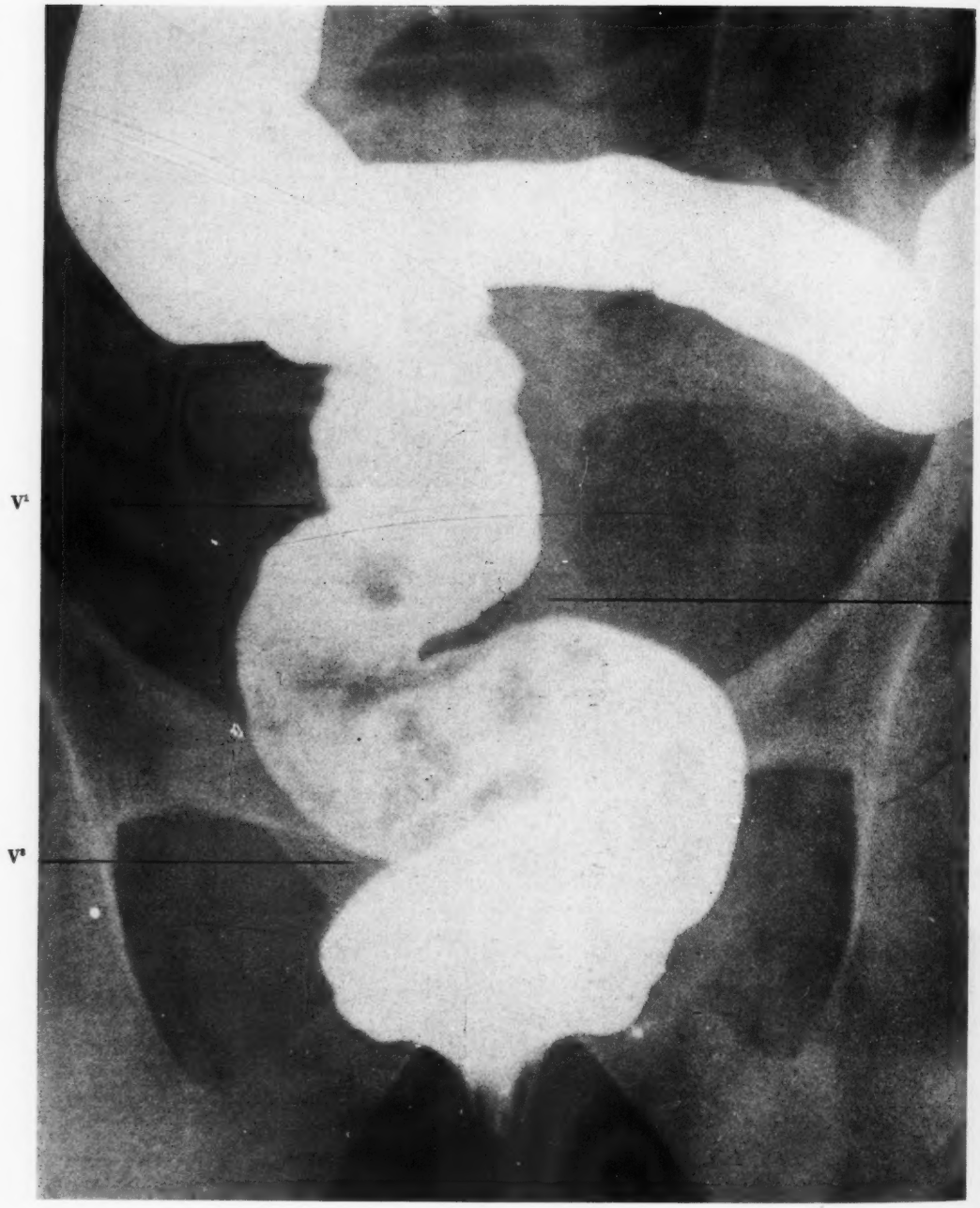


Fig. 115. Roentgenogram which shows Houston's valves (V) of the rectum. The valve (V^2) on the left side of the rectum is viewed on edge. Note that its appearance is similar to that of the sulcus angularis as shown in Figure 96.

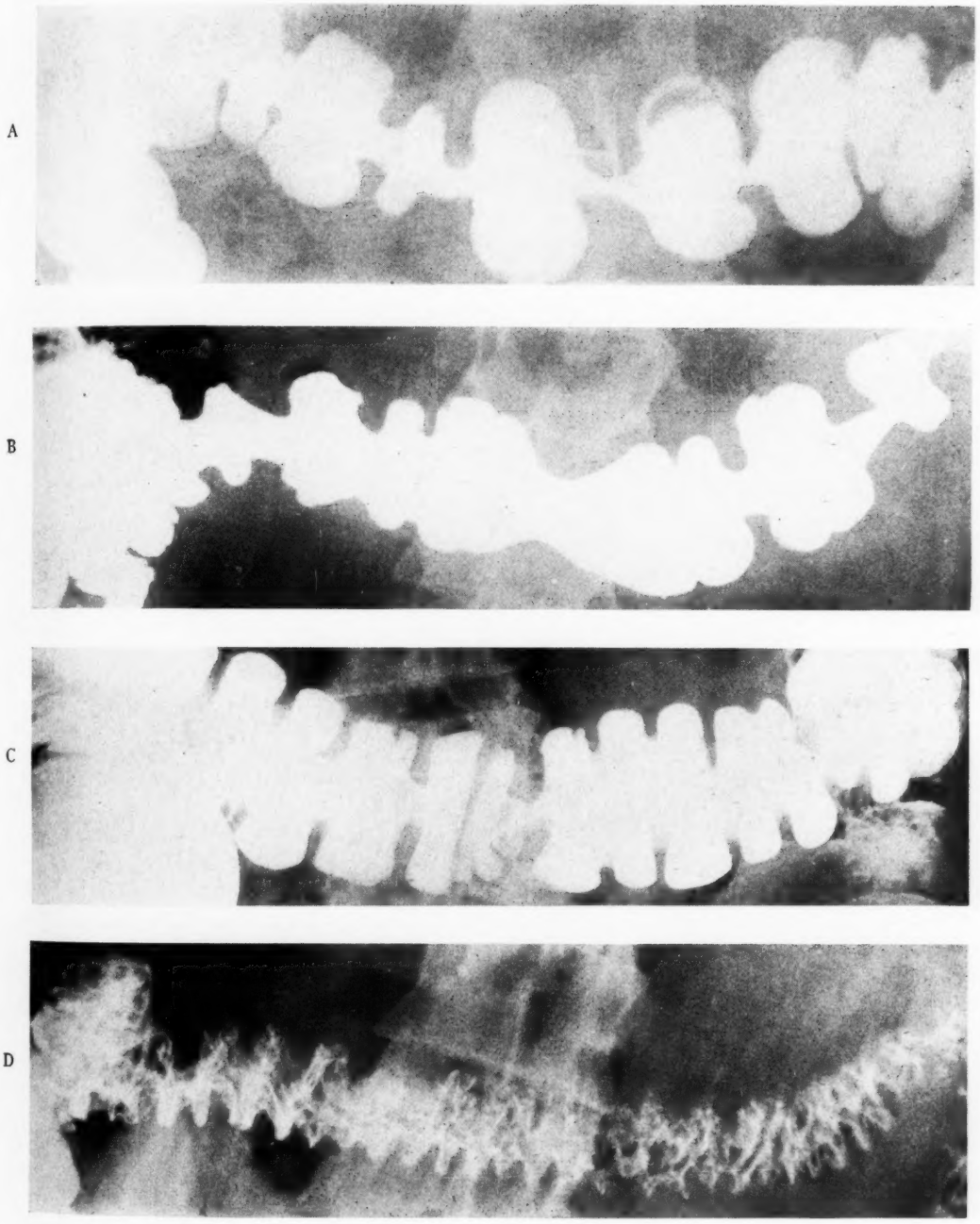


Fig. 116. Roentgenograms which show the roentgenographic appearance of the segmental folds in the transverse colon. *A* and *B*—24 hours after a barium meal: *C*—the colon distended with a barium clyster: *D*—the contracted colon after evacuation of a barium enema.

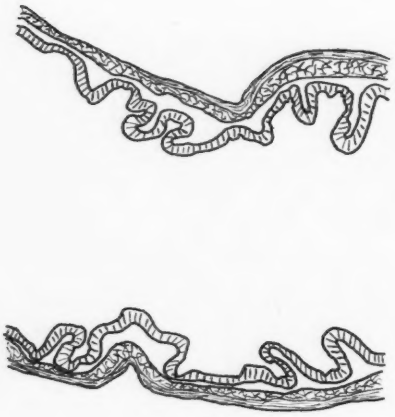


Fig. 117

Fig. 118

Fig. 119

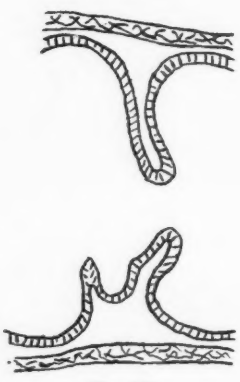


Fig. 120

Fig. 121

Fig. 122

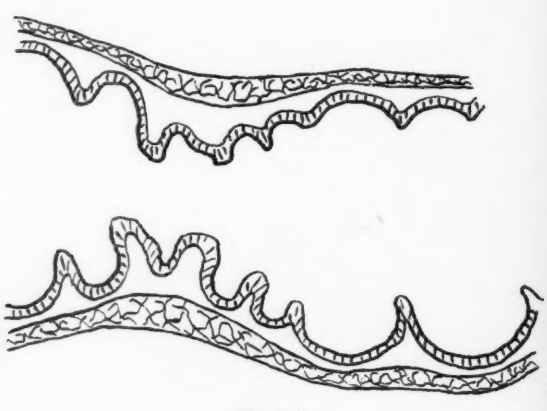


Fig. 123

Fig. 117 is a tracing of the outline of the coats of the colon specimen as cut longitudinally and shown in Figure 60. The tracing has been reduced to the actual size of the specimen. Using this as a model, in Figures 118-123 we have diagrammatically drawn the wall of the colon around the segmental folds as shown in the roentgenograms.

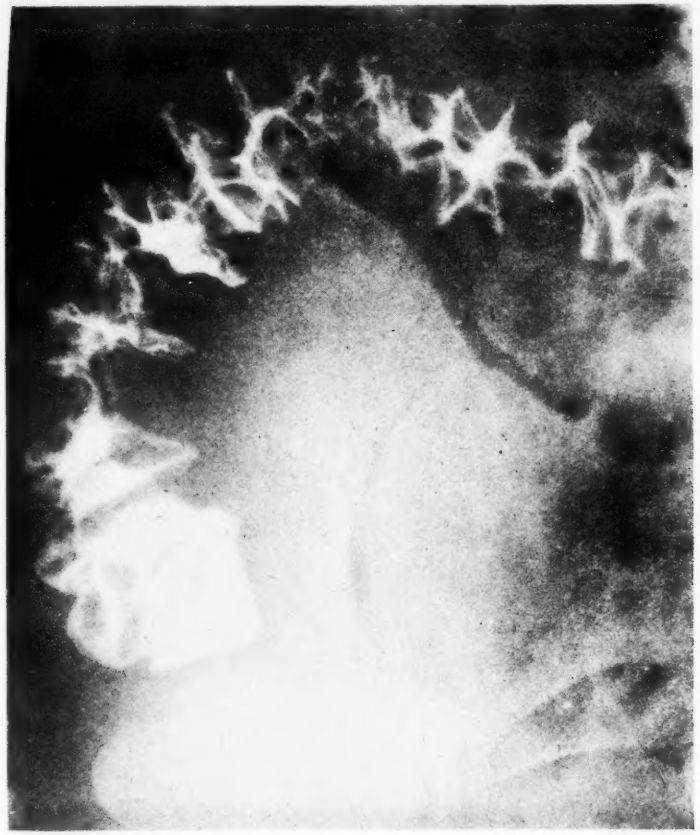


Fig. 124. Roentgenogram made after evacuation of a barium clyster shows the grossly serrated contour of the outline of the lumen of the contracted colon. The gross serrations are due to the segmental folds which have been flattened out and broadened by contraction of the outer muscle wall (muscularis propria).

Fig. 125. Roentgenogram made of the colon during the progressive formation of a long contraction causing a mass movement. At the actively contracting end (*X*) the mucosal and segmental folds are thrown forward ahead of the wave of contraction, the appearance being similar to the bending of tall grass as it is swept by a gust of wind. In the area of most intense contraction (*Y*) the mucosa is folded longitudinally. *AC*—ascending colon: *HF*—hepatic flexure: *TC*—transverse colon.

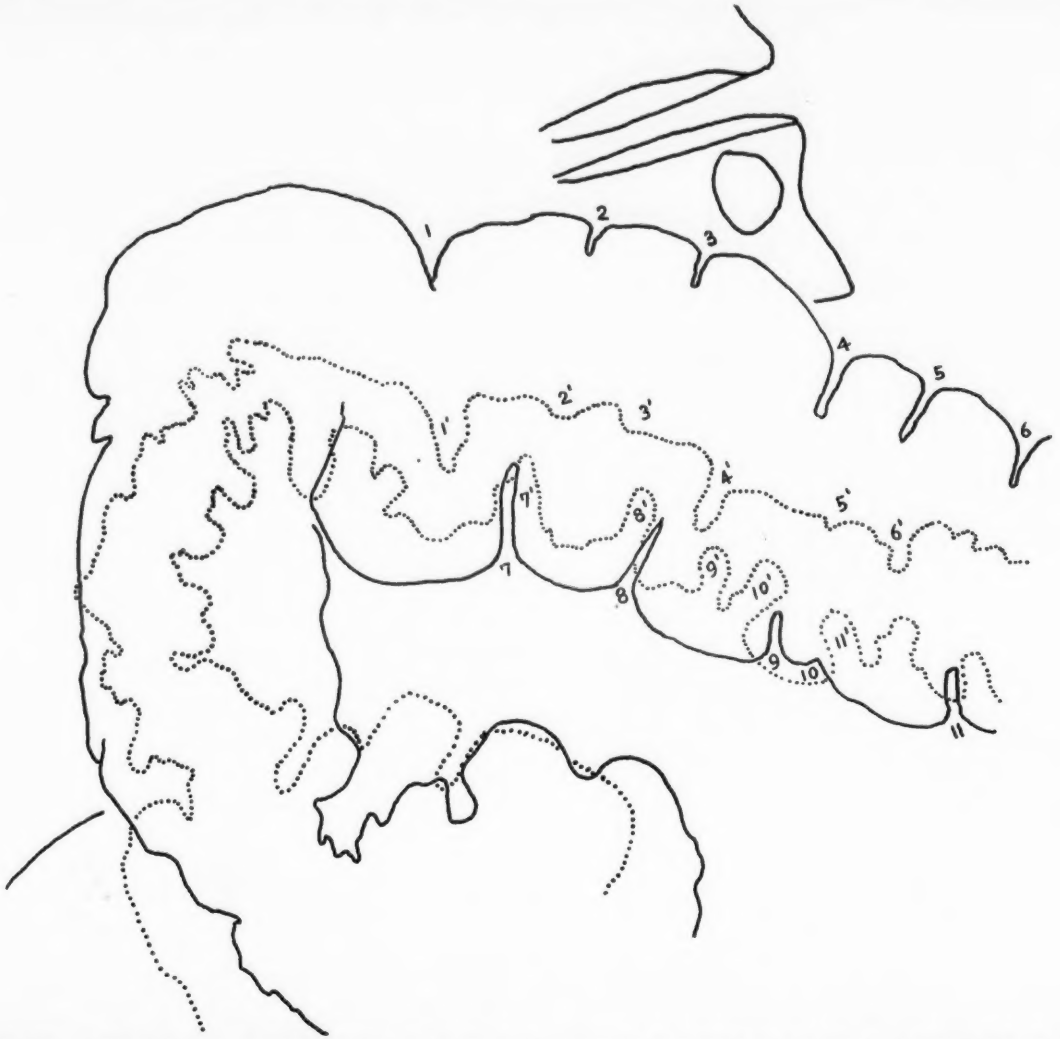


Fig. 126. Tracing of two roentgenograms from a series of roentgenograms made of the proximal part of the colon while filled with a barium clyster. The solid line (Film 5 of the series) shows the outline of the lumen when the colon was distended. The dotted line (Film 9 of the series) shows the outline of the lumen when this section of the colon was contracted.

The segmental folds which are present in the distended colon are not abolished by the extensive contraction of the muscularis propria, but may be identified as flattened out, broader folds. This finding shows that the muscle element producing the segmental folds is not the same muscle that produces the more general contractions and the mass movements of the colon.

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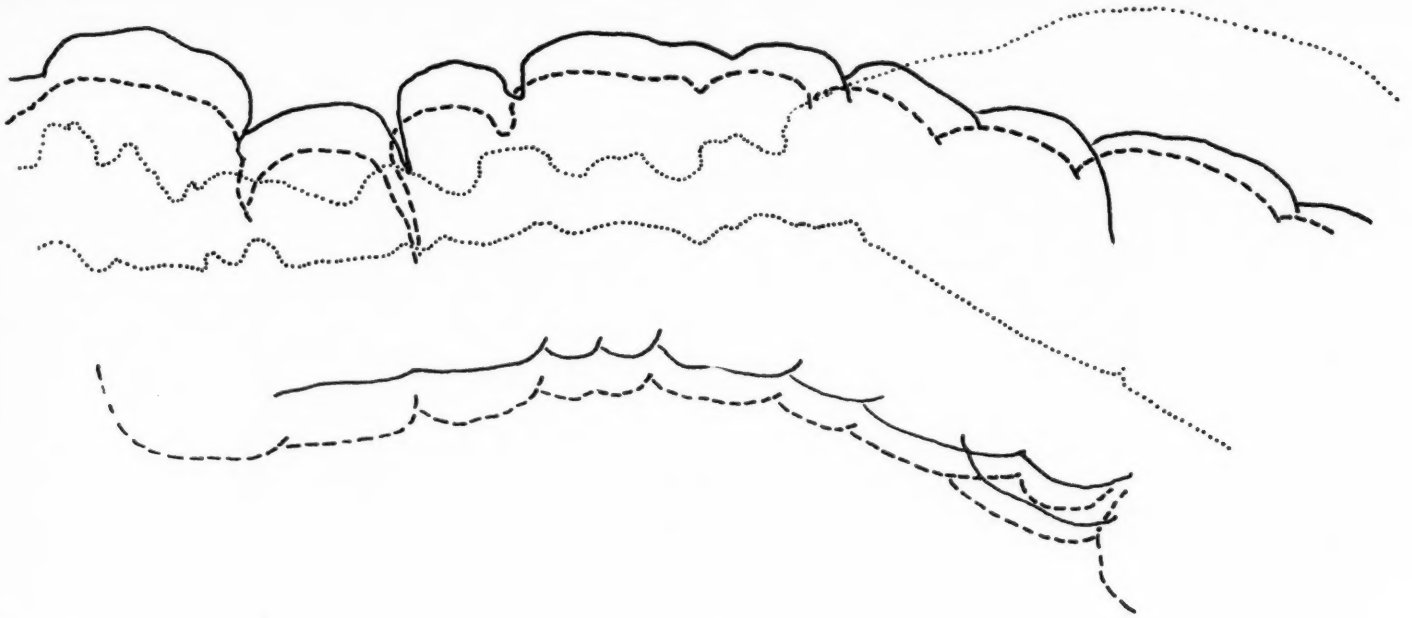


Fig. 127. Tracing of the lumen of the transverse colon as shown in three roentgenograms from a series of five which were made while the colon was filled with a barium clyster. The solid line is Film 1 of the series, the dotted line Film 2, and the broken line Film 4. There was a time interval of one minute between the making of Films 1 and 2, and an interval of two minutes between Films 2 and 4. Film 2 (dotted line) shows a mass contraction which occurred and relaxed during the interval of three minutes between the making of Films 1 and 4.

In the stage of contraction (dotted line) the imprint of the flattened segmental folds is clearly shown in the outline of the lumen. The most interesting finding, however, is the fact that the number and distribution of the segmental folds are absolutely identical in Films 1 and 4. This shows most clearly that a temporary extensive contraction of the muscularis propria may take place without obliteration of the segmental folds, and that following relaxation of the contraction and with the same distention of the gut the segmental folds will have identically the same form and distribution.

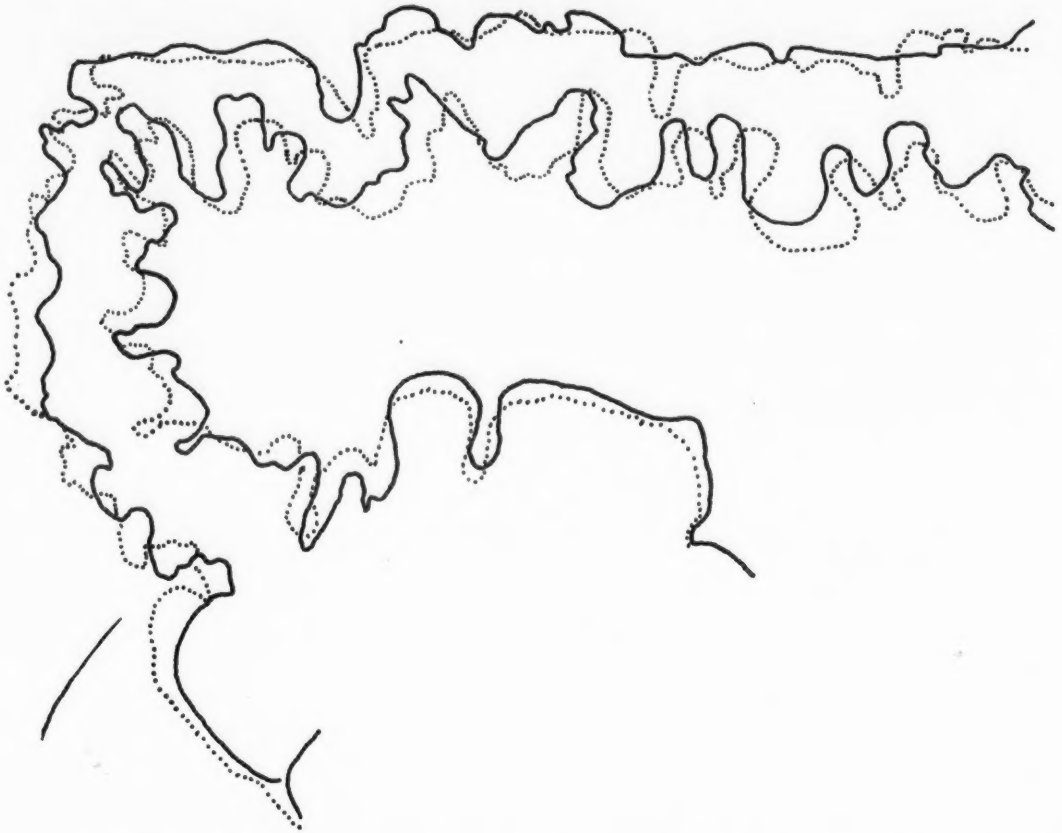


Fig. 128. Tracing of the lumen of the colon as shown in two consecutive roentgenograms from the same series illustrated in Figure 126. A time interval of approximately three seconds elapsed between the making of these two consecutive films. In this interval of time there is no change in the gross form of the outline of the colon, the indentations due to the segmental folds remaining present and changing only slightly in form. There are, however, many slight variations in the finer details of the outline. These changes may be due to varying degrees of tonus in the muscularis propria.

colon, the indentations due to the segmental folds remaining present and changing only slightly in form. There are, however, many slight variations in the finer details of the outline. These changes may be due to varying degrees of tonus in the muscularis propria.

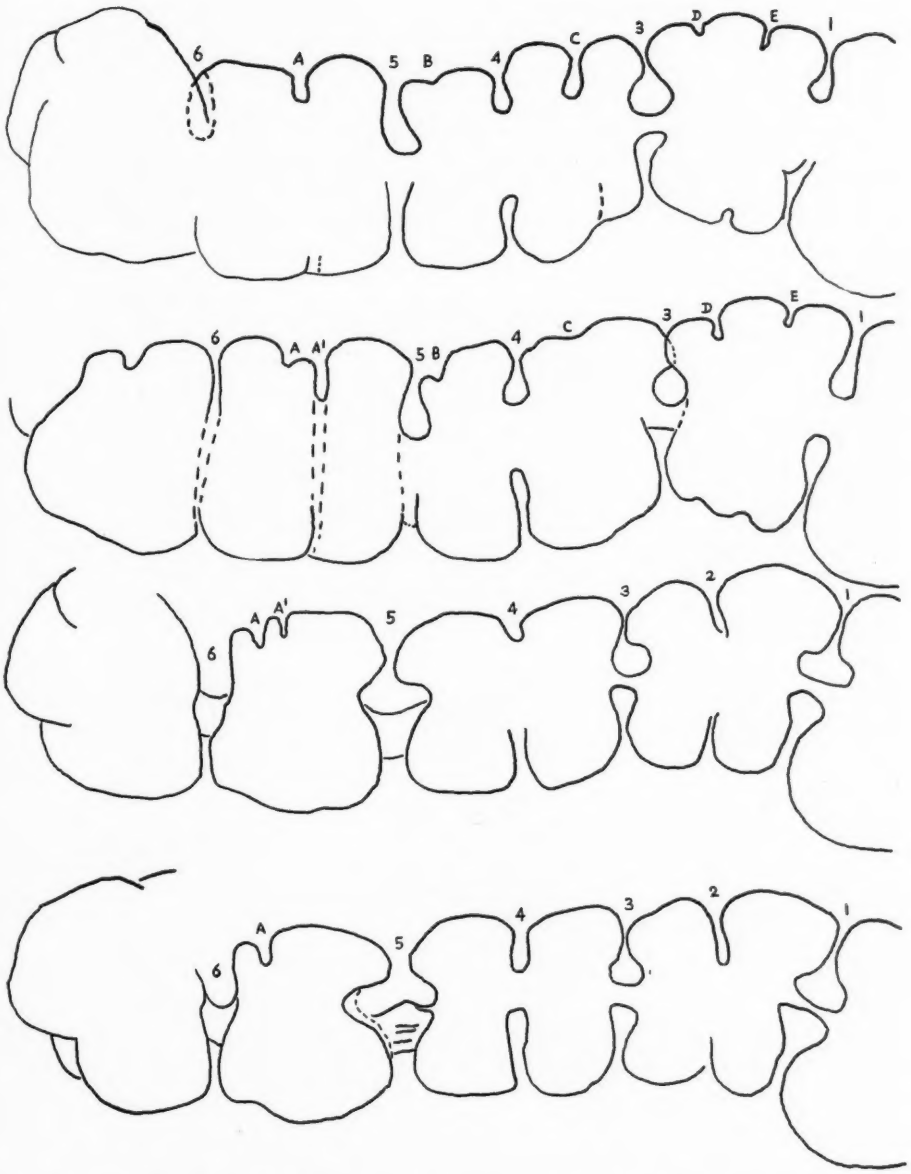
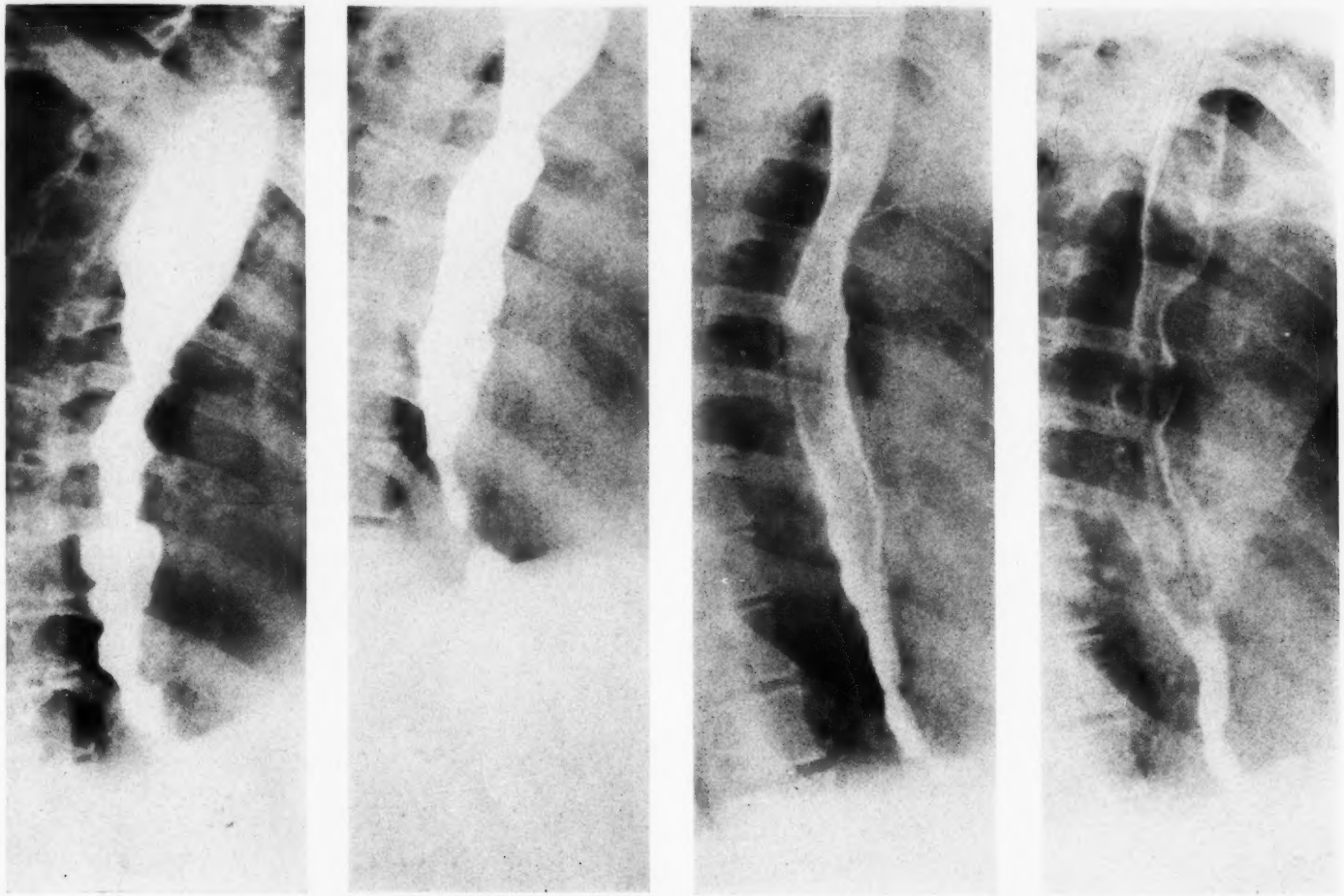


Fig. 129. Tracing of the barium outline of the lumen of the distal part of the transverse colon as shown in four roentgenograms made during a time interval of several minutes. The segmental folds 1, 3, 4, 5, and 6 show a definite variation in form, and folds 1 and 4 show a marked variation in depth. Fold 2 disappears and is replaced by two folds in a different location (*D* and *E*). At *A*, A^1, *B*, and *C* there are shallow folds which are not constant and are differently situated in the several films.



A B C D

Fig. 130. Roentgenograms made in the oblique direction with the patient in the recumbent (*A* and *B*) and erect (*C* and *D*) postures show unusually active and vigorous peristalsis of the esophagus secondary to a spasm of the esophagus at the level of the diaphragm. The absence of malignant infiltration is shown by the pliability of the wall to the peristaltic contractions. Diagnosis confirmed by esophagoscopy.

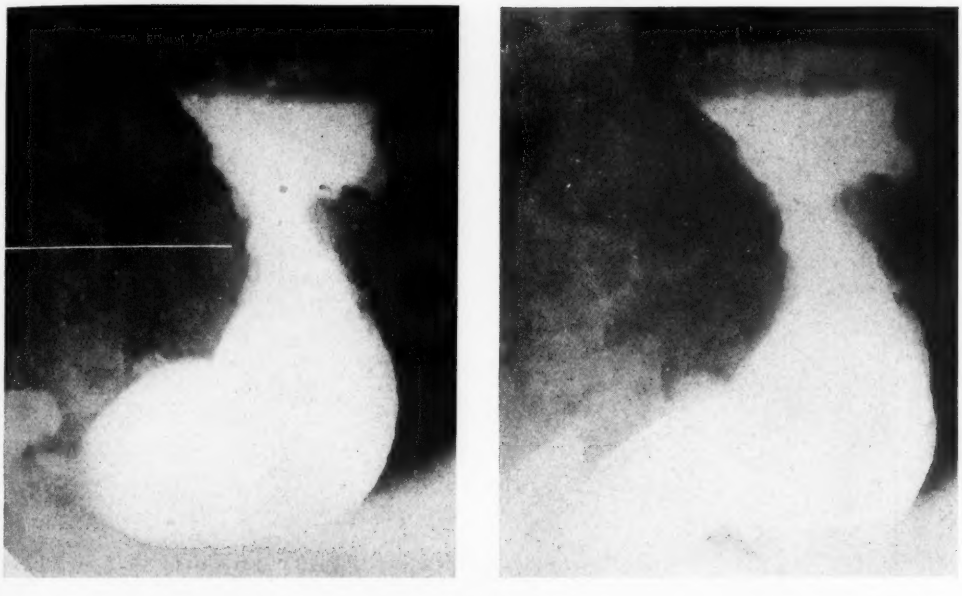


Fig. 131. Two of a series of roentgenograms which show obstruction of the peristaltic contractions by an area of malignant infiltration in the upper part of the corpus of the stomach. There is an ulcerated area (*U*) in the surface of the new growth.

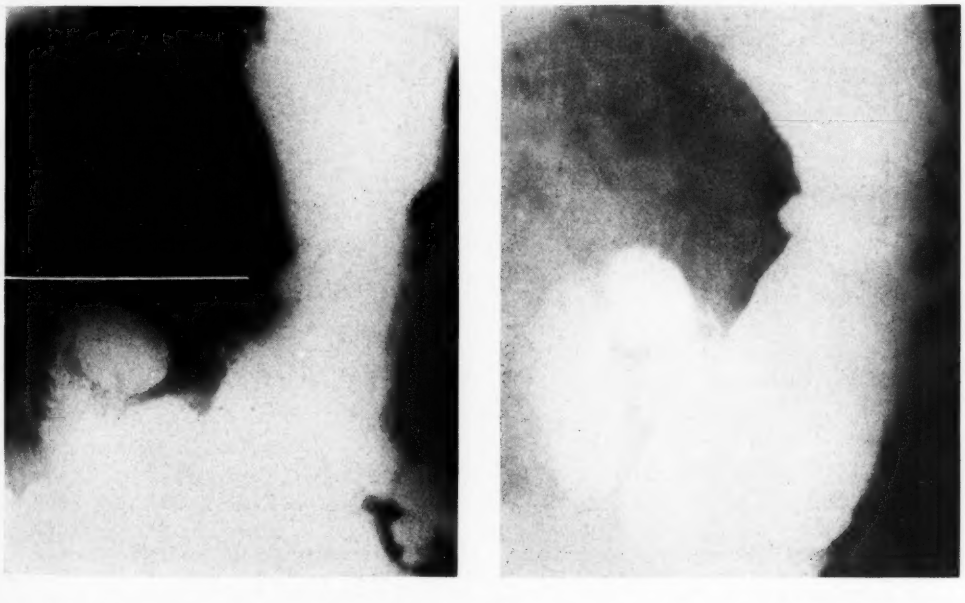


Fig. 132. Two of a series of roentgenograms which show obstruction of the peristaltic contractions by an area of non-malignant induration around a benign ulcer (*U*) on the lesser curvature side of the corpus of the stomach.

(*C* and *D*) postures show unusually active and vigorous peristalsis of the esophagus secondary to a spasm of the esophagus at the level of the diaphragm. The absence of malignant infiltration is shown by the pliability of the wall to the peristaltic contractions. Diagnosis confirmed by esophagoscopy.

Fig. 133. Roentgenogram which was made with three exposures in rapid succession. Each exposure was one-third the duration of the normal exposure. This is a simple method of determining whether or not the gastric wall is pliable to the peristaltic contractions.

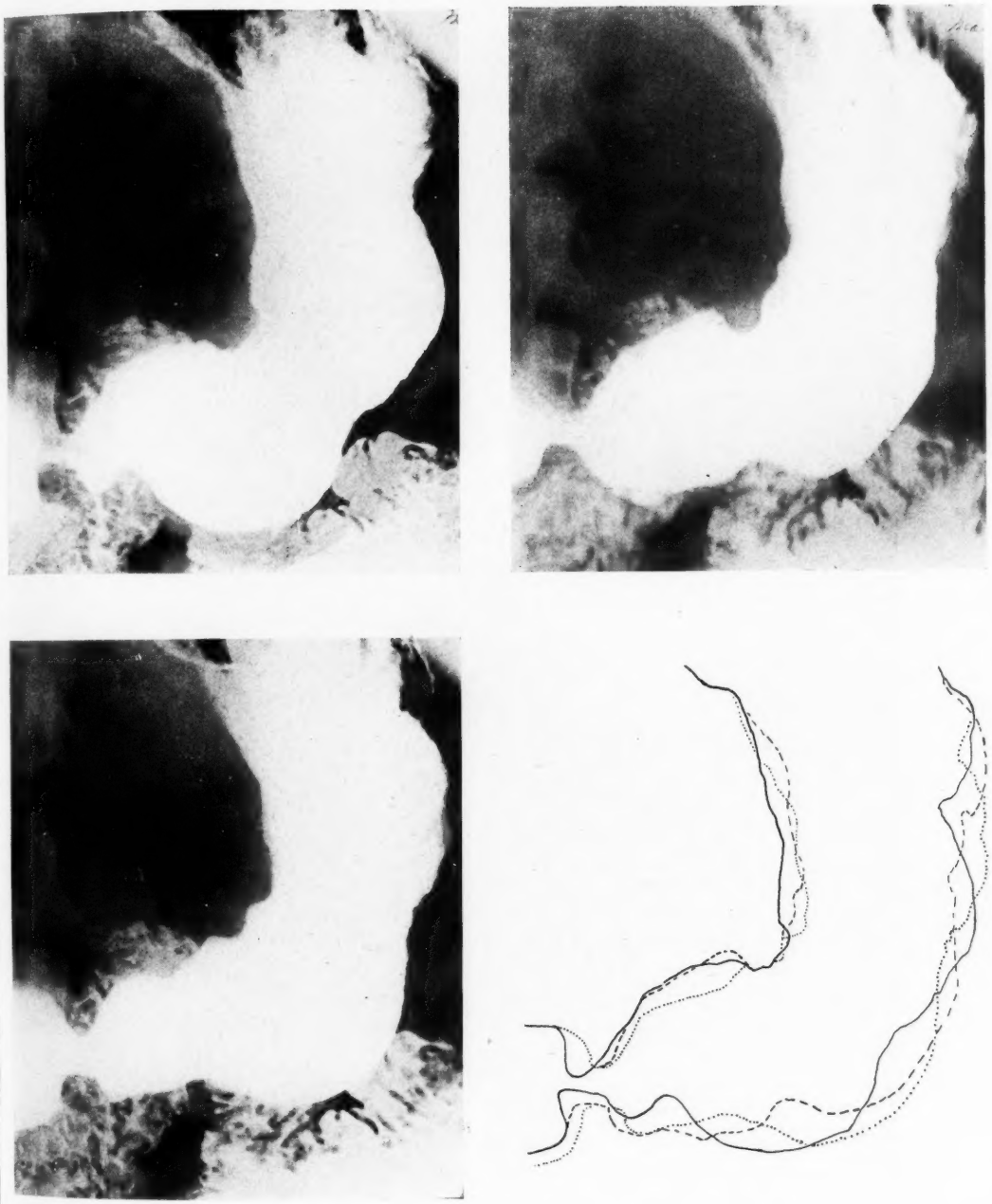


Fig. 134. Roentgenograms of three phases of the gastric cycle which show an extremely small area of lack of pliability on the lesser curvature due to an early carcinoma. The area in the diagram in which all three lines coincide indicates the area of lack of pliability. This finding might be due to either the scar of an ulcer or an early malignancy.

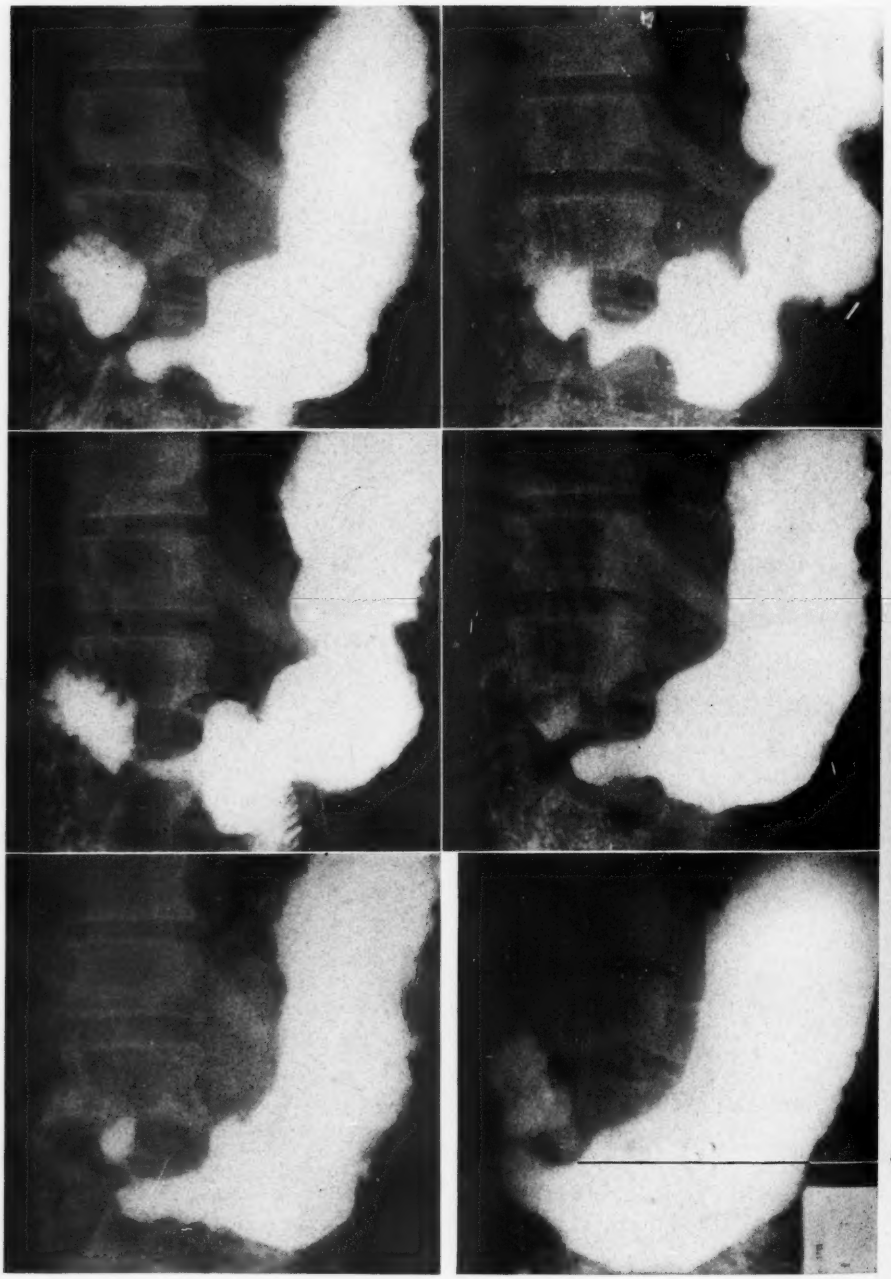


Fig. 135. A series of roentgenograms which show a very early carcinoma (*C*) involving the lesser curvature side of the pyloric canal. In this local region there is an absence of the concentric contraction and expansion of the pyloric canal. Expansion of the greater curvature side of the pyloric canal is limited but is present, and it contracts from its limited degree of expansion in a normal manner. This is the case which Ewing stated was the earliest gastric carcinoma he had observed in 40 years' experience.

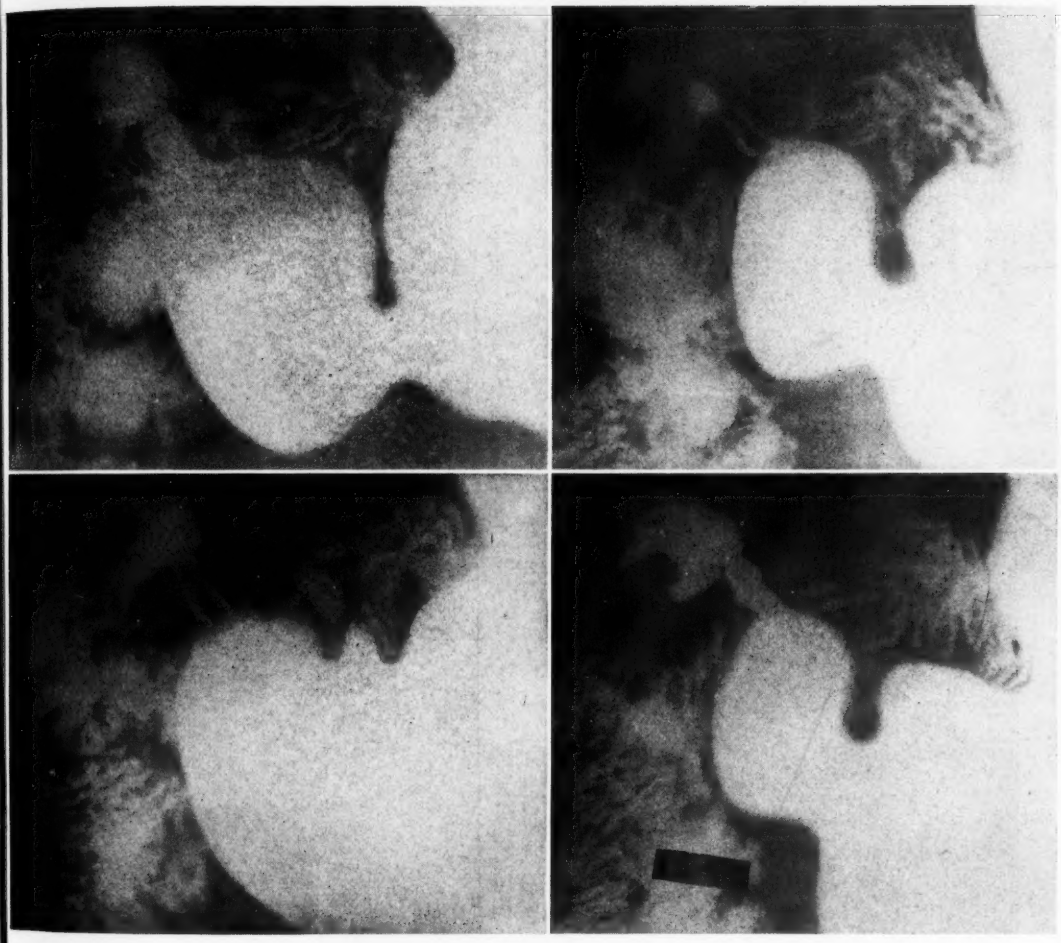


Fig. 136. Four of a series of roentgenograms made in the prone oblique posture which show a chronic spasm of the pyloric canal. This lesion is differentiated from malignant infiltration by the fact that the concentric contraction and expansion of the pyloric canal are not entirely destroyed, and by the presence of the normal longitudinal mucosal folds.

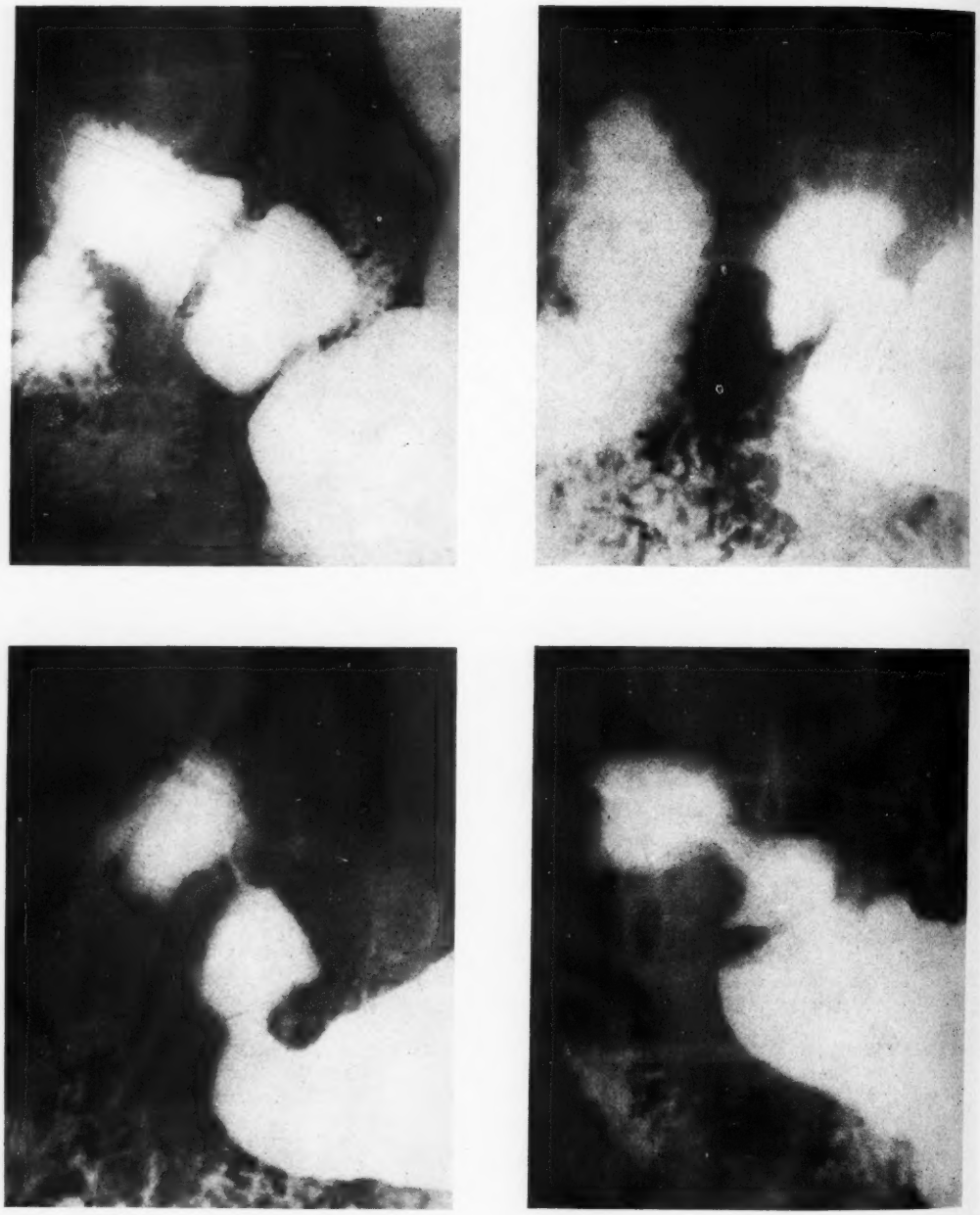


Fig. 137. Roentgenograms of four cases which show the cap being evacuated by a broad wave of peristalsis. The wave begins about the middle of the cap and carries the chyme from the top of the cap rapidly into the descending duodenum.

The case illustrated in Figure 135 entered the Fifth Avenue Hospital, New York, with a previous X-ray examination and a positive diagnosis by some other roentgenologist of gastric ulcer. A series of films were made, and the case was up for conference. The clinical history, course of the disease, and physical examination indicated gastric ulcer. This case proved to be of such great significance that we are inserting here a copy of our entire roentgenological report, *verbatim.*

A serial roentgen examination made of the gastro-intestinal tract immediately and six hours after the ingestion of a barium meal shows the size, shape, and position of the stomach and the emptying time of the stomach.

Stomach.—Type: orthotonic; deformed. Peristalsis: three- and four-cycle type; obstructed at the pyloric end of the lesser curvature. Systole and diastole: shown very distinctly. Pars pylorica: there is an area of induration on the lesser curvature about the size of an English walnut which involves only the lesser curvature, the greater curvature being pliable. This is constant throughout the entire series of roentgenograms. Prepyloric fold: not shown. Sphincter: slightly eccentric in position.

Cap.—Symmetrical in contour and not deformed.

At two hours the stomach is about three-fourths empty.

At six hours there is only a trace of the meal in the stomach and the head of the column is in the cecum.

Diagnosis.—There is an area of induration on the lesser curvature of the pyloric end of the stomach about the size of an English walnut which involves only the lesser curvature, the greater curvature being pliable. This is constant throughout the entire series of plates. This does not have all the characteristics of malignancy, but considering its size, location, and the age of the man I believe that the weight of evidence is in favor of its being malignant, and, considering that we always make a negative or positive diagnosis of malignancy, I should feel compelled to make a positive diagnosis of this being malignant.

I believe that one is justified in making a negative diagnosis of ulcer of the cap and postpyloric ulcer. I find no evidence of gallstones or a dilated or pathological gall bladder, but one is not justified in making a negative diagnosis of this condition solely on the roentgenological findings.

The patient was operated on and the specimen was photographed and taken to Dr. Ewing within two or three hours after its removal without its having been fixed or cut. After examining the freshly removed gross specimen and having cut it and palpated the surfaces, Ewing expressed the opinion that it was a normal stomach and that I had probably had the man's stomach removed when there was no lesion present. He added—largely to make me feel better—that the microscopic examination might possibly reveal something different. Two days later he called me up on the telephone with great enthusiasm and said that the lesion was malignant, and that he had waited for forty years to see a gastric carcinoma in as early a stage as this. A few days later he sent me the following communication:

DEPARTMENT OF PATHOLOGY, CORNELL UNIVERSITY MEDICAL COLLEGE

Report on Gastric Carcinoma

The material received consists of the pyloric portion of the stomach 11 cm. long and 15 cm. in diameter at its widest part. Surrounding the pyloric orifice

of 6 cm. there is a slight tumefaction of the mucosa, which on the surface is slightly nodular in diameter, where the mucosa is fixed to the muscularis and slightly eroded. The whole area is soft and lacks the usual induration of carcinoma. On section of the eroded area it is found that the mucosa or the thick opaque layer is 3 or 4 mm. deep and is fused with the muscularis. This condition extends over a zone 4 cm. wide. The serosa is normal, but the surrounding fat tissue is slightly adherent. After fixation in formalin the entire involved area, 6 cm., becomes boardlike, while the rest of the stomach remains elastic. The remaining mucosa shows a marked granular surface, indicating advanced atrophic gastritis. Just beyond the involved area, is a small polypoid projection 4 mm. wide, 2 mm. deep, which is the seat of the carcinoma.

Microscopic Examination.—The stomach is the seat of an infiltrating adenocarcinoma, which extends through the entire wall, splitting up the muscle fibers over a wide area, reaching the peritoneum and involving the blood vessels and nerve trunks. The main structure is simple tubular glands of various sizes, but there are numerous areas diffusely infiltrated by single tumor cells. There are numerous new lymph follicles. The ulceration is very superficial. The process arises in the tubular glands of an atrophic gastritis and these glands show various stages of transformation from simple atrophy to carcinoma.

Sections taken from the stomach wall, 11 cm. from the pylorus, show well marked chronic interstitial gastritis with much overgrowth of lymphoid tissue and considerable fibrosis.

Sections taken 7 cm. from the pylorus on the edge of the boardy area show diffuse infiltration of submucosa by cancer cells. This infiltration, although very scanty, accounts for the induration and restricted mobility observed in this segment. The mucosa in this zone shows very marked chronic interstitial gastritis with numerous groups of markedly atypical glands which show many stages toward, but do not reach, adenocarcinoma. These glands show how the original tumor began. It is interesting to note that these changes are identical with the ones found on the edges of old ulcers and are commonly interpreted as cancerous transformation of the ulcer.

Epicritical.—This case represents one of the earliest gastric cancers that I have seen, and one of the earliest that was ever encountered. It is particularly important in that it shows the development of carcinoma on diffuse chronic interstitial gastritis. The superficial erosion is characteristic of a large group of pyloric cancers which seem to develop in the same manner. The very wide infiltration of the submucosa also explains why in many of these cases the infiltration becomes almost universal throughout the stomach, but ulceration is very limited.

[Signed] JAMES EWING, M.D.

Cap.—The cap is evacuated by a broad peristaltic wave which begins about the middle of the cap (Fig. 137) and carries the chyme rapidly from the top of the cap into the descending duodenum and frequently through into the distal part of the duodenum or the upper part of the mesenteric small intestine. During and immediately following the partial emptying of the cap the craters of small ulcers of the cap are often rendered visible, although they had been concealed when the cap was full. The characteristic appearance of this broad wave of peristalsis is destroyed by cicatricial deformity of the cap.

Small Intestine.—The passage of chyme through the small intestine is ac-

complished by broad waves of peristalsis similar to the broad wave which empties the cap and carries chyme into the duodenum. The usual roentgenologic examination records only the fact that the barium meal passes in a normal or abnormal manner through the small intestine. In any roentgenogram made of the small intestine filled with barium, many of these broad waves of contraction may be observed. In cases in which one suspects a lesion in a local region of the small intestine it is very simple to determine by means of serial roentgenography whether or not the wall of the gut is pliable. Fortunately, organic lesions of the small intestine are quite rare and routinely one does not study the small intestine roentgenographically as closely as is really necessary to detect lesions which are not obstructive.

Colon.—Peristalsis in the colon is present as the long waves of contraction, which start from a definite ring of tonic contraction and progressively extend over a long section of the colon and cause mass movements of the contents of the colon. During the passage of the barium meal these extensive contractions are infrequent in occurrence and their detection is more a matter of accident than intent. When the colon is filled with a barium clyster, mass movement is likely to occur quite frequently, particularly if the colon is still under the influence of a stimulating cathartic such as castor oil. Progress of the contraction is extremely rapid. The ability of the wall of the colon to contract establishes the absence of infiltration of the muscularis propria.

THE NATIONAL INSTITUTE OF HEALTH[1]

By HON. JOSEPH E. RANSDELL, WASHINGTON, D. C.,
Former Senator from the State of Louisiana

RADIOLOGY is the youngest of the sciences devoted to the study of physical man, being scarcely more than a third of a century old. Its accomplishments have been marvelous, and there is general belief that the surface of its potentialities for preventing and curing the diseases of human beings has been barely scratched.

While neither a doctor nor a scientist, I have been intensely interested in health problems for twenty-five years, and as Executive Director of the Conference Board of the National Institute of Health I am devoting all my energies to the Institute—the Nation's research center in matters relating to public health.

The bill creating the Institute was first introduced in the Senate on July 1, 1926, but it met with discouraging indifference on the part of most of my colleagues and failed of passage. Believing that persistence is the only cure for such a malady, I again introduced the bill on Dec. 9, 1927. It fared a little better on this occasion, and passed the Senate, but was caught in a jam in the House and was killed by the termination of the session. In May, 1928, it was presented to Congress for the third time, and finally, on May 21, 1930, two years to the day after its third introduction, it received the approval of our legislative branch of government. President Hoover wrote the final chapter of this long story by signing the bill on the 26th of that month, and the National Institute of Health became a glorious reality.

During the four years of persistent effort following my first introduction of this measure many men of vision and love of their fellows assisted materially in making it understood by Congress and the country. This is especially true of the doctors, chemists, dentists, and other scientists who worked actively for the passage of the bill and secured resolutions indorsing it from their great national associations, thereby focusing the attention of Congress upon it. While a few Members of both Houses saw the exceptional merits of the measure and became crusaders under its banner, it was not until Senators and Representatives generally began to hear the voices of their constituents appealing for it that they gave it their support.

It is impossible to name all advocates of the bill, but I can not refrain from mentioning President Hoover, former President Coolidge, Secretary of the Treasury Andrew W. Mellon, and Francis P. Garvan, President of the Chemical Foundation (Inc.). These four great Americans saw with clear eyes the possibilities of the National Institute of Health for preventing and curing disease with its awful train of suffering and colossal economic losses to the world. Without their powerful help this dream of mine could never have come true. They and many others—especially doctors, chemists, and dentists—gave their wholehearted support to the measure, and I wish to express my lasting appreciation to them.

I can not say too much of the splendid co-operation of the Chemical Foundation, through its wise and generous President, Mr. Garvan, who is so favorably known to radiologists. He gave unceasing and effective aid to the bill in its legislative journey of four years through Congress, and made the first gift to the Institute of $100,000. I sincerely hope his example will shine brightly and be the guide for many Americans.

Societies such as yours are offered an

[1]Presented before the Radiological Society of North America at the Seventeenth Annual Meeting, at St. Louis, Nov. 30–Dec. 4, 1931.

ideal opportunity to co-operate with others in close union with the National Institute of Health under the terms of the act creating it. It stands ready to receive your aid in its search for solution of many unconquered diseases, which are still a curse to civilization. The Public Health Service, of which the National Institute of Health is a part, points to its wonderful record of the past and invites you to partake of the sacrifices and the glory which are the lot of scientific research workers in the cause of health. I trust you will join hands with this splendid agency and assist in giving to the world some measure of the true happiness which comes from good health.

While research activities in science have resulted in commendable reduction of mortality and alleviation of suffering we have not kept pace with the times in matters of public health conservation. It is a sad commentary on the agencies dealing with health that influenza and pneumonia are as deadly to-day as they were a hundred years ago; that cancer and heart affections are claiming greater tolls in lives each year, and that the population of our institutions for the mentally deficient is increasing at an alarming rate. Dr. Charles W. Mayo, in a recent speech before the Annual Clinical Congress of the American College of Surgeons, said: "The world has moved ahead so fast as regards material civilization that man has almost for the moment got behind in his power of adaptation. Every other hospital bed in the United States is for mentally afflicted, insane, idiotic, feeble-minded, or senile persons."

It is only fair to say, however, that our lagging in the matter of health research has not been due to the inefficient mentality of our scientists, but to the woeful lack of facilities and the discouraging insufficiency of funds to stimulate recruits in science. The crying need of the American scientist engaged in a study of health problems is a great laboratory fully equipped to cope with every disease where he can carry on his work in close co-operation with other students of the laws of life, and with every possible facility at his disposal.

Provision was made for supplying that need by my bill creating the National Institute of Health, which contains three distinct features:

First: It creates the Institute in the United States Public Health Service, under the administrative direction and control of the Surgeon General, for the special purpose of scientific research to ascertain the cause, prevention, and cure of diseases affecting human beings. It does not establish any new bureaus or commissions but utilizes existing Government machinery, provides for enlargement of the former Hygienic Laboratory, which came into existence in 1901 by congressional action, and appropriates $750,000 for the erection of additional buildings.

Second: It authorizes the Secretary of the Treasury to accept gifts for study, investigation, and research in problems relating to the health of man and matters pertaining thereto, with the provision that if gifts in the sum of half a million dollars or more are made, the name of the donor shall be perpetuated in a suitable way. This feature of the act is most unusual and important. No precedent can be recalled of donations from philanthropists to enable the Federal Government to maintain institutions for the purpose of research, with possibly two exceptions—the Smithsonian Institution and the Library of Congress. The Smithsonian was founded on the gift of $550,000 by James Smithson to disseminate knowledge among men. It stands as a monument to his name and its achievements are known throughout the world. The authorization granted to the Library of Congress to accept funds for special purposes has resulted in gifts to it exceeding $2,600,000.

Third: It proposes the establishment and maintenance in the Institute, out of funds donated for that purpose, of a system of fellowships in scientific research to encourage and aid men and women of marked proficiency to combat the diseases that menace human health. This provision of the act is regarded as its outstanding feature, for these fellowships offer an opportunity to those specially qualified to serve their fellow-men in the most useful of all ways. While it is contemplated that the bulk of research work will be carried on in the Institute laboratories in Washington, it is not so limited. Under the terms of the act these fellows can be assigned to institutions in any part of the globe, wherever the research problem may be undertaken most advantageously.

This Institute marks the beginning of a new chapter in the history of medicine of a most far-reaching influence in the relief of human suffering. The act creating the Institute is a veritable declaration of war against all the physical forces detrimental to health on a greater scale than ever before attempted. It centers in the Nation's capital all the country's medical and scientific resources for combating disease and creates in Washington a clearing house of health for all the world.

Under a commander-in-chief—the Surgeon General of the United States Public Health Service, with the director of the Institute as his first lieutenant in active charge—will be marshaled the Nation's army of experts in the sciences of medicine, surgery, psychiatry, dentistry, chemistry, physics, radiology, biology, bacteriology, pharmacology, pharmacy, and allied professions in a concentrated drive to prevent disease by ascertaining its cause and applying preventive measures in advance of its outbreak.

In the national capital has been founded an institution devoted solely to study, investigation, and research in problems relating to the health of man, where every available facility will be provided to aid and encourage scientists to combat sickness and solve the many remaining mysteries of disease, and where all knowledge and every advance in the promotion of human health will be pooled and correlated.

The plan of the Institute is to make of it an immense co-operative scientific organization, in which leading experts in every branch of science connected with plant and animal life will be brought together and given opportunity to work in unison for the purpose of discovering all the laws of life. Harmonious co-operation—one for all and all for one—is the watchword of the Institute.

In this Institute will be carried on new researches in cancer on a greater scale than ever before attempted, new investigations into the cause and cure of infantile paralysis and heart diseases, new studies of the common cold, influenza, and pneumonia; here will be made new discoveries; new and better methods of cure and treatment will be found to replace those now in use; and new and greater safeguards of health in general will be devised.

Although truly remarkable advances have been made in the war for health by individual scientists, by private and governmental institutions, no agency has ever been founded on earth for combating disease on so comprehensive and co-operative a scale as the National Institute of Health. While it is impossible to predict its eventual benefits to humanity, they are certain to be very great.

Genuine co-operation in science is necessary if the best possible results are to be obtained. Dr. Treat Johnson, of Yale, said: "Nothing can be done, no attack can be made on any (health) problem, except through the principle of co-operation. . . . No one to-day can cover any single field in

science individually and make progress. He must work in co-operation with others."

Until this Institute was created there was no place in which radiologists could meet their brother workers in other branches of science in order to formulate better means of preventing and eradicating disease. Dr. Julius Stieglitz, of the University of Chicago, deplored the lack of peace-time co-operation among scientists in the field of health, pointing out that in time of national danger from war a great mobilization of scientists takes place in order to bring into existence destructive forces with which to fight the battles of men. In 1923 he said: "There is no institution in which the chemists of the United States can come together with the medical scientists to inaugurate a general attack upon the forces that kill. . . . Let there be another war, and no doubt the chemists will be mobilized again, but they will be mobilized to kill."

The National Institute of Health furnishes the means by which can best be put into practice the "principle of co-operation," described by Johnson as being so essential to the success of the research expert. It is the agency which Stieglitz had in mind—an institution where radiologists and chemists can work in friendly union with every other branch of science to solve health problems, giving the benefit of their vast store of knowledge in alleviating pain and preventing sickness.

This act provides radiology with the opportunity to render a priceless service to humanity. The Institute enables it to bring into close co-operative effort with other sciences its research activities in a field that to-day comprises the most difficult and destructive of all unconquered diseases—cancer. Radiologists are devoting much time and attention to the study of this dread malady, which is causing untold suffering and death. While the span of life has been materially lengthened and the death rate in many diseases greatly reduced, cancer has not responded to scientific treatment, and its mortality rate has increased to alarming proportions. In 1850 approximately 30 people per hundred thousand died with cancer. In 1910 the figure had risen to 75, and in 1929 the fatalities from cancer had reached the appalling total of 115 per hundred thousand. In this great altruistic agency, which our Government has provided, you can bring into play, in connection with other sciences, all your skill and research ability to blot out this and other diseases.

Dr. Joseph Colt Bloodgood, one of America's ablest physicians and strongest believers in the merits of your science, who has devoted his great intellect to fighting cancer, and who is with us to-night, recently said: "No specialty in medical science and practice has developed more rapidly than radiology, both in its diagnostic and therapeutic aspects. . . . Radiology is now one of the greatest specialties in medicine. We owe a great debt of gratitude to the pioneers, many of whom have lost their lives because of their ignorance of how to protect themselves from irritation of X-ray and radium. . . ." May I add that in my opinion no science is destined to play during the next half century a greater part than radiology in the world-wide battle with disease.

The Institute stands sorely in need of added facilities with which to carry on its noble work. Only recently Surg. Gen. Hugh S. Cumming, of the United States Public Health Service, said: ". . . Probably the greatest immediate need of the National Institute of Health is the completion of its physical development, especially additional buildings to house a division of physics, where studies, especially of light and ventilation, as they affect the general health of the people, and of the use of X-ray and radium in the treatment of disease, can be undertaken; and a division of physiology, the work of which is intimately concerned with every division of the Institute. Other work which it is desired to take up as soon as

funds and facilities are available are studies of arthritis, focal infections and their relation to chronic degenerative diseases, degenerative diseases of the arterial system, the common cold, puerperal fever, life cycles of bacteria, etc."

The 1931 report of the Twentieth Century Fund (Inc.), entitled "American Foundations and Their Fields," states: "Judged by the amount of money donated in 1930 (by 21 leading American foundations, exclusive of private benefactions) the field of medicine and public health is the most popular, a total of $18,627,222 in grants to it having been reported in the returns. More than one-third (35.5 per cent) of all funds given away by the foundations canvassed has gone into this field."

Of this liberal sum, $8,396,932, or 45.1 per cent, was paid in support of educational activities; $8,401,825, or 45.2 per cent, in support of social action, and only $1,828,458, or 9.7 per cent, in support of research.

This is very striking, and shows that while American philanthropists, as represented by the report quoted above, were quite generous last year in support of medicine and public health in a general way, less than 10 per cent of these sums were given to pure research, without which it is impossible to ascertain the cause and cure of disease. It is unfortunate that so little was donated last year by these 21 foundations to health research, but I have no doubt that individual benefactions for that purpose were considerable.

Recently an article appeared in "Nation's Business," entitled, "My Money after I Die —by a Man who has Some." The author expressed an earnest desire to so dispose of his large wealth as to promote human happiness and make it continuously useful. Beyond question, suffering, sickness, and death will last until the end of time, and there is no surer way to make money continuously useful in promoting health and happiness than by liberally endowing the National Institute of Health.

Although the name and some of the facilities are new, the National Institute of Health has been a going concern for over 30 years, and has 155 persons hard at work every day on some phase of health investigation. It has been of tremendous aid to research in the world, and it is impossible to enumerate here even briefly the total of its accomplishments and contributions to science, yet a few points can be noted in connection with past and present work.

From the Institute have come Dr. Goldberger's monumental work in the discovery of the cause and prevention of pellagra; Dr. Francis's work on tularemia; Dr. Spencer's work on spotted fever and his discovery of a protective vaccine; the discoveries of Dr. Dyer, Dr. Rumerich, and Dr. Badger of an Eastern form of spotted fever, which may prove to be one of the most important public health problems; Prof. Voegtlin's fundamental work in the metabolism of normal and cancer cells; and Prof. Hudson's contributions to work on the chemical structure of sugars.

At the present time, under the guidance of its director, Dr. G. W. McCoy, studies are in progress at the Institute relating to nutrition, cancer, typhus-spotted fever, tularemia, infantile paralysis, undulant fever, spinal meningitis, ginger paralysis, standardization of certain drugs, fundamental researches on sugar, and many other problems. Lastly, through its work in the control and standardization of biologic products, the Institute has rendered a very great service to the people of the United States in safeguarding the numerous serums and vaccines placed on the market, and a number of the biological standards worked out at the Institute have been adopted by many foreign countries.

The advantages of having such an institution in the Government are apparent. It

belongs to the people and is responsible to them. Their problems are its problems. It provides for continuity. Research work should not be taken up and dropped at the whim of some capricious benefactor or changing board of directors. It requires years of continuous application to a definite plan which Government conditions supply. Again, the checks and control of Government financial methods assure us that money allotted to this work, whether from private donations or appropriations by Congress, will be carefully accounted for and put to good use.

The past record of the Public Health Service indicates that it is the agency *par excellence* to lead in this great public-health movement and that Congress acted wisely in confiding to it the entire management and direction of the National Institute of Health. The service now has a large corps of trained personnel engaged in scientific investigations in many parts of the country, which can be most effectively used as a nucleus for developing the necessary organization to undertake the proposed researches in the Institute.

Not only does the Public Health Service have in its ranks many experienced and scientific workers but it also has laboratory and other equipment that is being used to great advantage in research work. I can not say too much about the work of the United States Public Health Service, which for many years has aided the States in times of epidemic, has made exhaustive studies in health conditions, and, in general, has been a most important factor in reducing mortality in this country.

In conclusion, let me appeal to you and to all radiologists to devote your vigorous young intellects to the alleviation of human suffering. Your science can be of invaluable assistance to the National Institute of Health in making of it a truly great research institution, thereby fulfilling its noble destiny. Good health is the most precious of earthly blessings. Nothing can take its place. With it, one can enjoy life amid great hardships. Without it, vast wealth can not bring happiness. To attain this great blessing we should strive so earnestly that when our earthly careers are about to close each and every one can say in the language of the immortal Pasteur, "I have done what I could."

Would Investigate Effects of Radium Find on Evolution.—Do the great deposits of radium ore recently discovered in northern Canada have any effects in speeding up the rate of evolution of the plants and animals in their neighborhood?

This question has been raised by Prof. W. C. Broadfoot, of the University of Alberta, who calls attention to the now well-known ability of X-rays to speed up evolutionary change, first demonstrated to the scientific world by Prof. H. J. Muller, of the University of Texas. The effects of radiations from radium and other radio-active substances have also been the subject of numerous experiments, and of observations on living organisms in regions of high natural radio-activity in the earth.—*Science Service.*

TEACHING OF RADIOLOGY TO UNDERGRADUATE STUDENTS[1]

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RADIOLOGY occupies rather a unique position as a subject for teaching to undergraduate medical students. It is a new medical specialty. Its diagnostic and therapeutic applications have grown at a tremendous rate and have become unusually widespread. While it is more or less intimately concerned in every branch of medicine, its development has been left largely in the hands of a comparatively few medical men, assisted in a great measure by physicists and manufacturers of equipment. Its development and its position as a specialty have been taken largely for granted by the greater part of the medical profession. Comparatively few students or recent graduates expect to take it up as a specialty or even to practise it directly in a smaller way, although it must serve all of them. For these reasons, little earnest thought has been given to radiology from the standpoint of undergraduate teaching, aside from the desire and pride on the part of radiologists to further the interests of their specialty. The latter attitude is but natural, for, as Barclay[2] states, "when a teacher is placed in charge of a special department, it must be his aim and object to further its interests."

REASONS FOR TEACHING UNDER-GRADUATES RADIOLOGY

While radiologic specialists are constantly urging their claims for teaching privileges, the question frequently arises no doubt in the minds of medical faculties as to why any extended instruction in radiology to undergraduates is necessary. This can be answered by numerous reasons, which, because of their multiplicity and complexity, require enumeration:

1. The intern and the comparatively inexperienced young physician should know something about a means of diagnosis and treatment which either must call on frequently for assistance. Perhaps this appeals to me more than it does to some of the younger generation because my student, intern and early medical experience was gained in the first years of roentgen diagnosis and treatment, when there was no teaching of any kind on the subject. Impressions of roentgenograms and the reasons for therapeutic actions and their effects were as vague as they possibly could be on any subject pertaining to medicine. When, as an intern, I was shown the roentgenogram of a chest, no mental impression whatever was made of the patient's condition because of an utter lack of knowledge of anatomy and pathology as they might be expressed by roentgenographic shadows and appearances. The intern of the present day, however, realizes something of the value of roentgenologic studies because he has been taught something about the subject. He has some understanding of normal and pathologic appearances when they are demonstrated to him. He even learns to interpret abnormalities for himself.

2. To-day one seldom sees a clinical journal that does not contain important references to roentgen diagnosis or therapy. Must the intern or the young physician skip over these references without a proper understanding of them?

3. Roentgen diagnosis now is applicable to every branch or specialty in medicine. In surgery, every fracture and dislocation must

[1]Read before the Annual Congress on Medical Education, Medical Licensure and Hospitals, Chicago, Feb. 16, 1932. Reprinted by permission from the *Journal of the American Medical Association*, March 19, 1932, XCVIII, 938.

[2]A. E. Barclay: The Dangers of Specialization in Medicine (the thirteenth Silvanus Thompson Memorial Lecture). British Jour. Radiol., February, 1931, IV, 60-82.

be examined, not only because of the aid given to the surgeon and patient but also because of almost a legal requirement. The roentgenogram is the most satisfactory and safest means of diagnosing and studying bone diseases and tumors in most instances. Nearly all surgical gastro-intestinal lesions are diagnosed or confirmed by roentgenologic study. The detection or confirmation of a large number of urologic conditions depends on roentgenologic assistance, often aided by intravenous or retrograde urography. Diseases of the gall bladder, intracranial lesions, many intrathoracic conditions and a host of others require study by this method. In connection with internal medicine, the radiologist has to search for foci of infection in the teeth and sinuses. Practically all intrathoracic conditions require more or less roentgenologic study. The digestive tract and the gall bladder constitute a wide field for investigation. In addition, there are bone, joint, soft tissue and many other conditions for which examinations frequently must be made. The pediatrician frequently calls for assistance in examinations of the sinuses, mastoids, pharynx, chest, and bones. The orthopedist would be lost without roentgenologic aid. The bronchoscopist could do but little without it. The laryngologist requires it constantly, and the neurologist very frequently. Thus, radiology is practically a specialty within specialties.

4. The student should be taught the value of, and in many instances the absolute necessity for, roentgenologic diagnosis as well as its limitations, for he is soon to become an intern. As such, he is in many instances the one to request roentgen examinations, until, perhaps, the radiologist has reason to mistrust his judgment and insists on a higher authority.

5. The student of to-day should be taught not to depend on roentgenologic aid at the expense of other and older diagnostic methods. He must learn to realize that such studies are expensive procedures for patients and institutions and should not be employed unnecessarily. On one occasion, an intern requested studies on a single patient in a ward which would have cost the institution over seventy dollars had they been carried out. A large part of this general examination was found to be entirely unnecessary.

6. There is a tremendous amount of mediocre roentgenologic work being done to-day by untrained and inexperienced men, and much of it is practically valueless and even misleading. The student and, later, the intern should be taught to realize this, so that when they enter into practice they may be able to judge what is dependable and what is not. Nevertheless, one should not be too hasty in judgment of diagnostic ability on the basis of the appearance of roentgenograms, for they may have been made under unusual and difficult circumstances beyond control if poor, or, on the other hand, some men can produce excellent technical results without having the ability of correct interpretation.

7. To establish the fitness of the young practitioner for such judgment and understanding as have been specified requires that instruction of some kind should have been instituted during his student days, whereby he could have gained some knowledge of normal roentgenographic appearances, their variations within normal limits, and the modifications produced by pathologic processes. By the time of his graduation and the beginning of his internship he should be able to understand the principles of interpretation of living pathologic conditions in roentgenologic terms. The internship would then be the time for him to gain what is needed in the way of experience.

8. Roentgenology is largely but not entirely in the hands of the medical profession to-day. Whether it will eventually fall more and more into the hands of commer-

cial enterprises outside of institutions depends almost entirely on the proper teaching of the younger members of the profession of the interrelation of radiology with the other branches or specialties of medicine. There is a growing tendency, apparently the world over, in the direction of commercialism, even with the vicious habit of fee-splitting. Lack of oversight in this particular line of work only serves to encourage similar proclivities in others. Haenisch,[3] of Hamburg, in a recent memorial address, when commenting on the misfortunes arising from the rapid expansion of radiology when it lacked the co-operation of other specialties, made the following statement:

"The harm, however, which resulted from a too rapid expansion of the art and the consequent faulty, insufficiently prepared training was not the worst. This could, if the will were present, be minimized or even eliminated. Much more disastrous was the fact that the incompetent and dishonest elements grasped this specialty. These, in some instances, were unscrupulous physicians who were guided merely by the expected pecuniary advantages and who, unhampered by clinical and roentgenological knowledge and experience, 'sold X-ray pictures,' paying the referring physician rebates or commissions. . . . In other instances laymen, with or without connivance of dishonest physicians, saw in the purchase of X-ray apparatus a get-rich-quick scheme at the expense of innocent patients."

These practices are all too common, and their elimination must be a co-operative process, and the warning and the education cannot come too early.

9. Radiation therapy has a large share of importance in the treatment of neoplastic disease and many other pathologic conditions. To-day, operative surgery, electrothermic procedures, and the use of roentgen rays and radium are the only approved methods of dealing with cancer, which is one of the most important conditions with which we have to deal in these modern medical times, because it is second in mortality rate among adult diseases. The greatest efforts are being made by interested medical bodies to teach the public and, still more important, the medical profession, the importance of early diagnosis and proper treatment. It is generally agreed by these bodies that the proper time to *begin* this instruction is in the undergraduate medical schools. The teaching is preferably to be carried out by cancer clinic groups, but in lieu of this it must emanate largely from the surgical, medical, and radiologic groups. Many of the unethical and unscientific methods of treating cancer could not flourish to the extent to which they do to-day did they not receive encouragement from men who have not been properly taught. Irradiation is a part of the therapeutic armamentarium of the dermatologist, and the student should be able to understand why it is used on the basis of biologic effects.

10. The dangers from excessive X-ray exposure should be understood, especially as they may be experienced in roentgenography and fluoroscopy for various purposes. Radiologists are frequently embarrassed by the lack of knowledge of these dangers on the part of the medical profession in general.

METHODS OF TEACHING

The reasons so far enumerated would seem to constitute ample justification for instruction in radiology during the undergraduate and intern periods. The latter is an ideal opportunity, but this aspect of the teaching problem will not be considered here. Fortunately, intern instruction is prescribed by medical boards in many States. My only suggestion in this connection is an insistence that the groundwork should begin during

[3] G. F. Haenisch: Roentgenology as a Specialty (the Caldwell Lecture). Am. Jour. Roentgenol. and Rad. Ther., December, 1931, XXVI, 821-833.

the undergraduate period. The next arguments are over the time, the place, and the method. Barclay states: "It is quite true that the overburdening and consequent extension of the medical curriculum is due to the increase in specialization. . . . The student of to-day has a far greater load of learning to cram into his head than he had a few years back, far more than he can ever hope to remember." The method of general didactic class instruction in radiology as carried out in most institutions in the past has been a failure in many respects. It has certainly not accomplished the desired results, and the only service it fulfils is to give the class as a whole some idea of the scope of radiology, and this is not sufficient compensation for the time and effort. Didactic teaching by lectures to hitherto untaught students means in part the showing of series after series of roentgenograms or lantern slides representing pathologic conditions which the student sees with little or no understanding of their import. Even were he shown the normal first, he cannot correlate that appearance with the structures of the human body represented because he has never been taught to do so. The futility is realized when the teacher reads examination papers or asks even the most practical questions at the end of the period. A few exceptional students may have grasped the subject, but the large majority have not. Didactic lectures are better adapted to graduate students who have received sufficient groundwork in the subject to enable them to absorb and assimilate that kind of instruction. Didactic teaching of radiology had its inception largely in the fact that no text-books were procurable on the subject, whereas this method has gradually declined in other specialties as suitable collateral textbooks have become available.

Human psychology requires that the reasons for certain results must be explained if these results are to be understood and are to make any permanent impressions on memory. Hence, if the student knows why and how roentgenographic and fluoroscopic appearances are brought about or biologic effects are produced, his mind will be more receptive in the way of interpretation of shadows of the body structures and the indications for treatment by irradiation and the results obtained thereby. Therefore, in teaching radiology it is necessary to preface the practical aspect of the subject by a short course of instruction in physics. This must be didactic, but it should be made as elementary as possible and, at the same time, interesting. It should have been taught as a pre-medical subject, but this seems seldom to have been done, or, at least, not in a manner capable of impressing the students in a way a teacher of radiology would desire. The most appropriate time for it, or, at least, to review the necessary part of the subject of physics, if it must be included in the undergraduate medical curriculum, would seem to be during the first year. Then there is more time for it and it can precede any practical teaching. Surely the medical practitioner should know something about the physics pertaining to X-rays and radium and the physical problems involved in their application. It need be but a small percentage of what the radiologist must know and even make use of every day. The physician should be able to talk intelligently with his patients about what he orders for them, if nothing more. How many physicians know just why irradiation is used in cancer or the difference between radium and its emanation or the similarity in effects of roentgen rays and radium? The utter lack of knowledge by physicians of the most elementary facts concerning radiology is often ludicrous and, at times, even embarrassing to the radiologist. Their utter ignorance of nomenclature is all too apparent to editors of journals. The teaching of all the physics a student requires should take but a few hours.

In the teaching of radiology, all selfish motives of the radiologist should be ex-

cluded and he should formulate his plans in such a manner that the instruction may aid that of other subjects rather than take time away from them. Barclay says: "In teaching the radiological aspect of anatomy and physiology to men . . . I find that nearly all of them have forgotten these subjects to an astonishing extent. Surely there must be something radically wrong that this should be the case. I believe the trouble lies in the fact that these have become specialist subjects, taught by specialists, in departments that are separated from those in which the practice of medicine goes on." If this is true, as I believe it to be, at least to a considerable extent, is it not possible that the teaching of radiology might serve as a liaison between the clinical and the preclinical branches? As a matter of fact, such a purpose would seem to be a direct outcome of many proposed modern methods of teaching radiology.

When the internist presents a didactic or clinical lecture to his students, the latter have been prepared in anatomy, physiology, pathology, materia medica, applied therapeutics, and physical diagnosis for a better understanding of the clinical subject under discussion. This progression of teaching has been worked out through long years of experience. Somewhat similar methods of progression would seem to be applicable to the teaching of radiology. Instead of a curriculum which prescribes a course consisting of a series of didactic lectures on the general subject, suppose we substitute one in which the roentgenologic aspect of anatomy, physiology and pathology in the living subject is considered in connection with the teaching of those branches and, later on, with the diagnosis of living pathology in the clinical branches.

One of the greatest misfortunes of the early radiologists was their enforced neglect of the study of the normal. When they started their work they were obliged to delve immediately into the abnormal without an adequate knowledge of what was normal. Fortunately this has been realized and has been corrected to a great extent, but not entirely. Inadequately trained individuals are often prone to interpret normal variations as evidences of disease because of their lack of knowledge of roentgenologic anatomy, physiology and pathology. One of the most flagrant examples of this was the one-time popular peribronchial tuberculosis. Unfortunately, too many of us were culpable in this error. Unfortunately, the assertions of insufficiently trained radiologists have been accepted by unsuspecting clinicians who did not realize the absolute necessity for a proper anatomic and pathologic knowledge in roentgenographic interpretation. As a result, men by the wholesale were kept out or put out of the military services or were granted undeserved compensation because of alleged tuberculosis without any true pathologic basis in roentgenograms. The radiologists of the future must be properly trained on the basis of our experiences of the past. Why should not the proper form of instruction be given, though on a much smaller scale, of course, to the physicians who must, in the end, be the real judges of the fitness of radiologists when the health of their patients is at stake?

RELATION TO OTHER BRANCHES

Anatomy, one of the first basic branches, is a study of the normal. It is not a subject to be "crammed" and all too soon forgotten. Whether it is covered during the first year or, better, during the first two years, that is the appropriate time for demonstrations of normal living anatomy as depicted on roentgenograms or by fluoroscope. This could be done all at one time, but preferably, as each part of the body is taught, the normal roentgenographic appearances could be demonstrated. This would include the skeleton, with adult appearances, and also a short demonstration of epiphyseal

development, with an explanation of what the roentgenographic appearances mean at different ages. I never knew just what an epiphyseal separation really was until I saw it demonstrated roentgenographically in intern days. The relations of the bones at the various joints and in the spine should be described anatomically and then roentgenographically. The student seems utterly at sea when shown roentgenograms of sinusitis, mastoiditis, pituitary tumors and the pathologic conditions demonstrated by ventriculograms and encephalograms. Surely, when the student is taught the anatomy of the head and brain he could be made to understand the roentgenographic appearances of the paranasal sinuses, mastoid cells, sella turcica, and cerebral ventricles. I always considered the latter and the circulation of the cerebrospinal fluid things to be learned and then forgotten until the advent of ventriculography and encephalography. Surely, typical normal encephalograms and ventriculograms could be advantageously used for demonstration purposes when these structures are considered anatomically. The entire digestive tract could be demonstrated roentgenologically, as the anatomy instruction proceeds. The student should be taught just how the radiologist sees it as a muscular tube with potential lumen when empty and with invisible walls, but only as a lumen shadow when filled with opaque contents. Later on he will be better able to understand how pathologic conditions will affect this lumen shadow. The kidneys, ureters, and bladder can be demonstrated by normal urograms after retrograde or intravenous injections of opaque substances. Normal gall-bladder demonstrations will be in order, with a few facts explaining the method of filling by the dye, although this would come more under physiology. In connection with the thoracic contents, the heart and vessel shadows should be demonstrated. Diaphragmatic excursion and cardiac pulsation should be reserved for section fluoroscopy. Group demonstrations would always be desirable for all this teaching, especially to permit of questions being asked by the students, but, if not feasible, much improvement in the present teaching plan could be made possible even by the usual class demonstrations of the various parts as the anatomic instruction proceeds. In all these demonstrations the student will be better able to understand why he sees the shadows of the structures shown if he has just received his preliminary short course in physics. Needless to state, these anatomic demonstrations should precede any attempt to teach roentgenographic pathology. All this anatomic teaching should be carried out in the medical department.

The course in physiology is an important teaching opportunity for roentgenology. Many of the important and really practical physiologic facts have been determined by fluoroscopic and roentgenographic observations, especially in connection with the digestive and urinary tracts. A number of the older beliefs have been entirely changed, and yet it is surprising how slow physiologists have been in appropriating this means of gaining knowledge, and it is inconceivable how known and recognized roentgenologic discoveries have failed to appear in textbooks. Barclay calls attention to the persistence of the Alexis St. Martin observations in modern print when they are manifestly absurd in the light of our present knowledge of gastric motility. How many physiologists teach that the stomach cannot empty properly when the individual lies on his left side; that peristalsis is a mixing mechanism in the stomach but largely propulsive in the intestine; that it and general gastric tonicity together are responsible for motility; that the shape and position of the stomach depend on the build of the individual, tonicity and the amount of contents; that there are such conditions as gastric compensation and decompensation; that pyloric spasm is in-

duced by heavy exercise after a meal, mental fatigue and headache, and that most or all of these phenomena can be demonstrated easily by the fluoroscope? Students seldom know the differences in motility of the upper and lower small intestine and of the mass type of peristaltic phenomena of the colon, and yet these are all practical facts. Several men have followed Cannon in this line of investigation, but many have not. During recent studies of the normal swallowing act I have been surprised at the inaccuracies of physiologic statements concerning this mechanism or the lack of them. Barclay[4] has been struck by similar observations. It is almost inconceivable how the radiologist could have progressed as he has without the help of the physiologist, but it is conceivable that progress could have been more rapid with the physiologist's co-operation in the early days. It is quite easy to demonstrate how coarse foods remain much longer in the stomach than semiliquid suspensions of finer food particles. This is an example of information that would be of value in connection with later clinical teaching. Demonstrations of barium enemas would be most instructive even if made but once to each student. The pulsations of the heart and vessels, the normal movements of the diaphragm domes and the costal movements with respiration would be so spectacular as to be easily remembered by the student. Naturally, all such demonstrations could be witnessed by only small groups of students at a time. The dangers of exposure should be considered carefully as they apply to both observers and subject, and all such demonstrations should be under the direction of the department of radiology.

Pathology is the next branch by which the student should be helped toward an understanding of the practical aspect of roentgenology. Any teaching along this line should follow that of the normal, as already described. Pathologic anatomy in conjunction with roentgenology should be taught, first, from the standpoint of the manner in which the disease affects the structure directly and grossly, and, secondly, as it alters function, because roentgenology is essentially a study of pathology in the living subject and thus differs from morbid anatomy as it is usually understood. The student should learn the actual gross and microscopic pathology first and then be taught to apply that knowledge to roentgenographic and even fluoroscopic appearances, just as the trained roentgenologist has to do every time he attempts to interpret evidences of disease in his roentgenograms or by roentgenoscope. The later didactic course in radiology will serve to show that when two or more pathologic processes present similar or indistinguishable appearances the clinical aspect of the case at hand, that is, history and clinical observations, must be carefully considered in the rendering of a correct interpretation by the process of exclusion. It is probable that, when the student has become familiar with normal roentgenographic appearances, typical roentgenograms of pathologic conditions will serve the pathologist well for demonstration purposes, not only when teaching from gross specimens, but also in general didactic instruction in various pathologic conditions. Needless to say, a normal roentgenogram of the structure should always accompany that of the pathologic condition under discussion, as, for example, cancer or ulcer of the stomach, intestinal neoplasms, bone tumors, aneurysms, heart conditions and many other intrathoracic lesions. It would seem almost if not quite as important to teach roentgen appearances in pathology as it is the histologic pictures of the processes. The roentgenograms of the patient should always be on display in the autopsy room, especially when students are present.

[4]A. E. Barclay: The Normal Mechanism of Swallowing. Proc. Staff Meet., Mayo Clin., Sept. 10, 1930, V, 251-257; British Jour. Radiol., December, 1930, III, 534-546.

PLACE IN CURRICULUM

The question naturally arises as to how

all this instruction is to be carried out in connection with the preclinical branches, and especially in a minimum of time in an already overcrowded curriculum. The time factor in the problem may be disposed of first. All the demonstrations mentioned would be of comparatively short duration and form really a part of the teaching of the branch in which they are included. Many of them would lead to a better understanding of the subject at hand, especially from the practical point of view. I believe that the results obtained would amply pay for any extra time consumed.

It would seem preferable for all this preclinical as well as subsequent instruction to be under the direction of the professor of radiology, and for the teaching or demonstrations in each branch to be arranged through agreeable co-operation with the professor in each. There could be one fully equipped roentgenologic department in the medical school, with a well trained technician in charge who could handle all demonstrations and also take charge of all experimental work, as in research surgery, physiology, anatomy, pharmacology and other branches requiring it. This technician would not be a teacher. There are two ways in which roentgenologic teaching could be carried out. The first would be directly by a representative of the department of radiology. The radiologic staff in a teaching institution and hospital must, of necessity, in these days, be a large one. There must be a professor at the head and at least one or two associates. The assistants are frequently two-to-three-year fellowship men, who are to become the trained radiologists of the future. They usually have minor faculty appointments. Technicians must look after all the details of purely technical work. One or more of the associates or fellowship men could be appointed to look after all the details of the instruction in the preclinical branches. The other plan would be to place this instruction in the hands of trained and competent members of the staffs of the branches, but with the department of radiology having a co-operative oversight. A combination of the two plans might be found advantageous. Decentralization of radiology is usually not a successful venture in the long run. It is a duplication of effort and is expensive and is not conducive to the best interests of teaching in general. It leads to a one-track mind, whether applied to anatomy, physiology, or clinical subspecialties, and fails to preserve the active spirit of co-operation so essential to the perfect teaching machine. The trained and experienced general radiologist is in a better position to see how the teaching in connection with all the branches can be best correlated. Clinical radiology is not laboratory work as we usually understand it. The trained radiologist must have a far wider vision than any laboratory chief can possibly have.

In the third year, the student should be taught to correlate his knowledge of anatomy, physiology, and pathology in a clinical application. The instruction should also be in the nature of a review, which intensifies the mental impression that may have been made previously. After such preclinical teaching as has been outlined there should be a striking difference in the student's receptivity to the clinical application of roentgenology compared to that which is possible when the attempt is made to teach him pathologic roentgenology only at this time, and without any preliminary introduction. The third year instruction under the radiologic staff, who can best correlate previous, present and future teaching, should cover a period of from sixteen to eighteen weeks during the last half of the year, with a weekly demonstration lecture. Each one should be elementary and based only on typical pathologic cases or examples. All exceptional and confusing cases should be absolutely ex-

cluded, and as few illustrative ones used as possible. Continuous didactic lectures illustrated by numerous films or slides shown in rapid succession make but little mental impression on the student, who is still very much a novice. An ideal way would be to divide the class into small sections for demonstration purposes, with each member of the staff teaching a small group simultaneously. Few institutions are equipped to do this, however. While actual didactic lectures should be avoided as much as possible, a few of them are necessary, especially in connection with radiation therapy, which is preferably a fourth year subject, however.

In the fourth year, roentgenology and clinical medicine and surgery and the special branches should be still further correlated. The plan we have followed for a number of years has worked out very satisfactorily. A class section of about twenty students spends an hour a week for six to eight weeks in a medical roentgenologic conference in which the director or professor of radiology is the leader and with the medical staff in attendance. Individual cases with which the students are familiar are discussed from the standpoint of history and clinical observations by the medical staff. The roentgenograms are then demonstrated and the roentgenologic deductions presented. The students are requested from time to time to attempt roentgenographic interpretations and are urged to ask questions.

Similar conferences are held weekly on surgical cases, with the surgical staff in attendance. After the roentgenologic deductions have been made, the surgeon in charge of the case in question briefly reviews the operation and gives the operative observations. These conferences last throughout the fourth year, so that each student has from twelve to sixteen hours of instruction. A similar plan is carried out with the pediatric staff, although student attendance is optional.

In addition to this, clinical medicine and surgery, and even some of the other specialties, should be taught with the use of roentgenologic data from roentgenograms as a part of the clinical picture of each case under discussion. Probably the subject of fractures is universally taught in this manner. The student will have a much better understanding of what the roentgenograms are intended to convey if he has had such preliminary training as has been outlined. In more or less didactic teaching of clinical subjects, roentgenograms of typical cases might well be shown, with normal roentgenograms for comparison, as a part of the clinical picture of each disease.

As has been previously stated, the preferable method of teaching radiation therapy would be through the agency of a cancer clinic group. The student should be taught unbiased views in regard to the indications and limitations of radium, roentgen rays, surgery and electrothermic methods. He then understands the necessity for early diagnosis and is prepared to go out and choose between accepted and unethical and unscientific methods of treatment.

The foregoing recommendations prescribe what would seem to be an ideal method of teaching radiology to undergraduate medical students and its correlation in a practical way with preclinical and clinical specialties. They are not entirely personal views but include also the ideas and even the practices of many teachers of radiology. They are offered for the purpose of general consideration with the hope that they may assist in the betterment of at least a small part of the medical curriculum.

THE TEACHING OF RADIOLOGY TO INTERNS[1]

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THE average physician cannot boast of great familiarity with the conduct or interpretation of roentgen examinations, or of adequate comprehension of the possibilities of diagnostic aid to be obtained from X-ray studies. His contact with X-ray problems consists in the main of emergency cases in which fractures or dislocations are suspected, and occasional reference of cases to X-ray laboratories for a "picture" of the lungs, stomach, or urinary tract. He has not appreciated that, in addition to skeletal diseases and injuries, roentgen studies may be applied with advantage to nearly all visceral disorders, including many diseases of the nervous system. He does not stop to realize that examination with the X-rays is much more complicated than the simple taking of a "picture"; that it is really no more a simple laboratory procedure than an ophthalmic examination or a urinary tract examination or a gynecologic study, and that a clinical knowledge of the conditions entering into his problems is a necessary part of the preparation of the radiologist. The "picture" of the stomach turns out to comprise a careful fluoroscopic investigation supplemented by anywhere from three to a dozen or more roentgenograms in various positions and under various circumstances according to the individual case. The "picture" of the lungs proves to be much more involved, the patient requiring fluoroscopic study in the erect position at various angles, with films to record whatever may be questionable or of especial interest; and sometimes it is advisable to make a screen study of the patient in the horizontal, prone, supine or lateral position, and to record the results with the necessary films. All of which sounds, and in actuality is, much more complicated than the simple word "picture" would imply, and yet to the layman who hears the X-ray study spoken of as a "picture," the physician's use of this term only serves to strengthen his impression that a roentgen examination is nothing more than some sort of glorified photography.

The remedy lies in some measure in the widening of the horizon of the general practitioner in relation to X-ray matters by having the radiologists of the country enter into a campaign of education through staff meetings, county society and other medical meetings. To a certain degree, perhaps as rapidly as possible, this is being carried on at the present time; but the logical and most important step is to carry this education to the young graduates of medical schools while they are in their intern year.

Medical students receive a certain amount of instruction in radiology, mostly in connection with X-ray investigations made in relation to the various patients with whom they come in contact during their clerkships and clinics. In addition, most medical school curriculums now include required didactic courses in roentgenology, usually in the Senior year, and in many there are well trained roentgenologists who carry on excellent systematic courses of lectures and demonstrations to the students during both the Junior and the Senior years. Many schools make it possible for their students during their Senior year to serve a clerkship in the X-ray department. Thus, when the graduate of to-day comes to the hospital as intern he already possesses a good foundation for further elaboration of his knowledge of roentgenology.

Statistical data from 619 hospitals approved for interns indicate that more than

[1]Read before the Annual Congress on Medical Education, Medical Licensure and Hospitals, Chicago, Feb. 16, 1932. Reprinted by permission from the *Journal of the American Medical Association*, March 19, 1932, XCVIII, 936.

80 per cent offer instruction in X-ray work. In some, provision is made for the rotation of the interns to include a brief service in the roentgen department, and in some of the larger hospitals there is a special X-ray internship. In others, occasional lectures are arranged to be given by the members of the staff of the roentgen department so that the interns may have more or less systematic instruction in roentgen diagnostics and therapy. In most hospitals, however, observation leads me to believe that the X-ray instruction given interns is desultory and not under definite check. The idea seems to be that the intern may absorb his knowledge of radiology while making rounds with the attending physicians and surgeons. In small institutions this is perhaps a necessary procedure, but in hospitals where the services of a trained roentgenologist are available it would be well for the interns to get from him also his slant on the meaning of the roentgen examination. The attending staff has a duty and a privilege in collating the roentgen observations with the other clinical and laboratory aspects of each case; whereas the roentgenologist, no matter how familiar he may be with the clinical and laboratory observations in a case, must not read into his roentgenologic interpretation more than can be supported by the X-ray evidence. It is well for him to know as much as possible about each case, the more the better, but he should not put into writing as a part of the X-ray report any statement which cannot be substantiated by the X-ray evidence.

PROGRAM OF INSTRUCTION

It is evidently quite necessary, if interns are to be given X-ray instruction, to formulate a definite program which can be followed out. Let me consider some of the things I believe it essential for an intern to learn about the X-rays. Naturally, the extent to which this ideal can be carried out depends on the size of the hospital.

1. *The nature and origin of X-rays and of secondary radiation, and the physical and biologic laws that apply to them.* This may be accomplished by reading text-books, and it may have been done by some of the interns, but a systematic review should be made of the subject. Only by appreciating the physical facts will the intern ever learn to take care of himself and his patients during roentgenologic investigations and therapy. He should be taught the necessity of constant protection by lead-rubber aprons and gloves; to conduct roentgen examinations with expedition; to realize that proper filters must be kept in place between the source of the rays and the patient, whether for therapy or for examination, and that that most inexorable of laws, the inverse square law, applies to all radiation (including radium and ultra-violet rays). He should learn that the patient becomes a potent source of secondary radiation against which protection must be provided.

2. *The scope of roentgen examinations.* In his daily work the intern learns the general applicability of the roentgen rays to diagnosis, but the refinements of X-ray diagnosis should be systematically brought to his attention by didactic work. There are conditions not encountered in daily work in which the average physician will not think of a roentgen examination; for instance, acute intestinal obstruction, subphrenic abscess, pulmonary and pleural abscesses, perirenal abscess, certain abdominal abscesses, the measurement of the size and the position of certain viscera such as the liver and spleen, and the application of opaque oils and other opaque media to the study of the sinuses and fistulas as well as certain organs into which such opaque oils may be introduced. The localization of foreign bodies is a field in which most physicians do not know (or else have forgotten) the value of the X-rays. Physicians with experience on the front during the War had brought home to them repeatedly the value of the X-rays in

localizing foreign bodies of all kinds, special emphasis being placed on fluoroscopic methods; yet how few seem to remember at this short interval since the War the efficiency and the speed of the fluoroscopic methods of routine use in war hospitals during hostilities. Peace-time studies have added non-opaque foreign bodies in the respiratory tract to the opaque foreign bodies detectable with the roentgen rays. Naturally the intern, even in his student days, became familiar with the scope of the roentgen study of the gastro-intestinal tract, the urinary tract, the lungs and bronchi, the heart and great vessels, and the skeletal injuries and diseases. It is important that in all autopsy and staff conference discussions the roentgen observations should be presented by the radiologic department and carefully correlated with the clinical and autopsy aspects of each case. It is a practice in one hospital, at least, to present at the autopsy room a roentgenogram of the chest, made postmortem, to bring further down to date the X-ray data on the thorax.

3. *Fluoroscopic control of the reduction of fractures and dislocations and in the removal of foreign bodies.* Some of the larger hospitals are equipped for biplane fluoroscopy for use during the setting of fractures and the reduction of dislocations, but the very accessibility of such apparatus may tend to relax one's vigilance against damage by the X-rays to the patient and staff. Every year new cases are brought to attention in which irreparable damage has resulted to physicians from injudicious fluoroscopy. When special apparatus is not provided for such work, improvisation can be made in the roentgen department or a portable X-ray instrument and a hand fluoroscope may be carried to the operating room, under which circumstances the danger of damage by the X-rays to the staff is greatly increased, to say nothing of danger from possible explosion from unwise choice of anesthetic agent to use under such circumstances. These precautions are all the more important if it is sought to use the roentgen aid in the extraction of an opaque foreign body. Here again one seems to see very little effort to use the fluoroscopic aid so widely taught in military surgery. Time and again one sees surgeons attempting the removal of superficially located foreign bodies in the good light of the operating room when, by the aid of the fluoroscope and a proper technic of protection against surgical contamination and roentgen damage, the offending substance may be extracted with great saving of time and no danger from the X-rays.

4. *Roentgen interpretation.* To develop skill in reading roentgenograms and in translating the appearances made manifest by fluoroscopy there must be opportunity for observation of and participation in fluoroscopic and X-ray film examinations, and for sharing in the conference at which the roentgenologist puts together into the written report the X-ray evidence shown by films and screen. To make this of teaching value, it is important that the roentgen department be furnished with a statement of the problem in each case referred for examination. It is not enough to refer the patient merely for an examination of such and such part; the examination desired should be stated, but, most important of all, the problem should be stated clearly. The referring physician had some reason for sending the patient for examination in the roentgen department; what was that reason? A tentative diagnosis would be ideal, but practically it seems impossible to get the co-operation of staff members to that extent. It is possible to insist on knowing the question that was in the referring physician's mind when he wrote the requisition and he should take the time and trouble to state his problem briefly.

5. *Roentgen terminology.* Terminology is of importance in the instruction of interns. It is difficult to change the habits of

a lifetime and, on the other hand, it is relatively easy to instruct young people just entering their practical experience. To a man who has all his life spoken of roentgen examinations as "having a picture taken," and who has been guilty of sending his patients into the X-ray department for an "X-ray picture of the gastro-intestinal tract," an "X-ray picture of the lungs," and of this, that, and the other thing, it is useless to talk about terminology. But the younger men are susceptible to persuasion and rule in this matter, especially when reason is used in talking with them. There is a certain dignity which belongs to all branches of the medical profession, and it is well to maintain that dignity. The surgeon does not speak of making such and such a "gash" or "slash" to "dig out" the appendix; that would be exceedingly undignified. He makes such and such an "incision" to "resect" the appendix. One does not "dig out" the prostate through a low belly "slash"; he "enucleates" the prostatic tumor through a "suprapubic incision." Just so, in roentgen terminology it is possible with a little care to school oneself to dignified language and to speak of "X-ray films," "X-ray examination," and "X-ray study" if one is determined that his tongue cannot negotiate the more cumbersome "roentgenogram" or "roentgen study." One of my dear friends protested that he could not curl his tongue around "roentgenogram," yet within two or three minutes he was talking about a nice case of urethral obstruction in which he performed a "ureteromeatotomy"! Proper terminology aids materially in the collection of fees that are necessary to carry on X-ray work adequately. The American Medical Association has published an acceptable list of radiologic terms.

6. *Therapy.* The field of roentgen therapy is so complicated that it is to be doubted whether more can be done in the way of instruction during the intern year than to teach the general principles of treatment, the selection of cases, the realization that it is possible to make accurate dosage, and the limitations of the method.

Circumstances will determine how far such a program can be carried out in the individual hospital. In large hospitals, with internships of from eighteen months to two years, it is quite reasonable that a portion of this time be given to the roentgenologic department, each intern spending a while in that department as a participating assistant. Such a stay should be for not less than two months, and three would be better. The practice of assigning an intern to the X-ray department instead of a place on a rotating service should be condemned; no fellow in the roentgen department should be accepted until after having served his regular internship, and preferably after a few years of general practice. Failure to observe this precaution results in unbalanced training, which soon becomes evident in the practical work of the fellow.

In some hospitals the interpretation is done at the same time during which the members of the attending staff are making their rounds, so that it is difficult for the interns to participate in the reading of the roentgen examination. In such cases it is feasible to arrange a certain hour at the close of the forenoon or at the end of the day for revision of some of the more interesting of the X-ray cases of the day. It is also possible for the staff to arrange that the roentgenologist shall give a series of systematic lectures and demonstrations covering the X-ray instruction deemed necessary.

Much good will have been accomplished if the intern on leaving the hospital can carry with him a thorough appreciation of the scope and limitations of the roentgen examination in various disease conditions, its value and dangers in the control of fracture and foreign body work, and its place with radium in the treatment of many benign lesions as well as in the management of malignant disease.

THE POST-GRADUATE AND GRADUATE TEACHING OF RADIOLOGY[1]

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RADIOLOGY is still a comparatively new branch of medicine, but its rapid development during the last thirty-five years, and especially during the last ten years, is deservedly attracting widespread attention. Moreover, its relations to many other phases of medicine are increasing day by day. In several phases of medical practice, in fact, radiology has already become an indispensable factor. Such evolution has been so rapid that, although many of the better medical schools provide more or less substantial instruction for under-graduates, little effort has yet been made to organize and provide thorough post-graduate or graduate courses. In this respect America has allowed itself to fall behind several European countries. In England, France, and Sweden, for instance, the teaching of radiology is well organized and has been placed on a higher plane than in any school in this country. This deficiency is now crying for correction.

Any consideration of post-graduate and graduate instruction in medical radiology must take into account a number of factors: the present status of the subject as it affects, and is affected by, other phases of medical practice; the existing plane of under-graduate teaching of radiology; the number of qualified teachers available, and the objects which an ideal system of instruction should seek to attain. It must be obvious that, without an ideal to strive for or a definite objective to attain, it would be difficult or impossible to construct a plan that could be expected to yield the desired result. In other words, the first essential is to know what is the desired result and to keep it clearly in mind. The main object of post-graduate instruction in radiology, it seems to me, should be to develop full-fledged specialists in this branch of medicine, masters of the subject, thoroughly equipped to practise the specialty, and worthy of public confidence. This, then, should be the ideal toward which we should strive. But before constructing a plan to achieve this result, it is important to inquire into the present status of radiologic practice. In a recent analysis I[2] have attempted to point out some of the undesirable conditions that characterize such practice at the present time, such as the comparatively low standards that countenance the reference of patients by their attending physicians to so-called laboratories operated on a commercial basis by unqualified laymen, the dependence of many physicians on interpretations of roentgenologic data by non-medical technicians, the treatment of patients by technicians without supervision by medically trained therapeutic radiologists, and the dearth of teachers of academic caliber. These different factors are so closely interrelated that to analyze and set forth precisely the influence of each factor is not a simple task. Nor is such exact distinction necessary. It is quite enough to know that these factors collectively constitute a sort of vicious circle. The one point at which this circle can be most effectively broken is that which relates to post-graduate instruction, because the present lack of such instruction furnishes the best opportunity for constructive action. It is true that the break is rendered difficult by the relative paucity of teachers, but the

[1]Read before the Annual Congress on Medical Education, Medical Licensure and Hospitals, Chicago, Feb. 16, 1932. Reprinted by permission from the *Journal of the American Medical Association*, March 19, 1932, XCVIII, 933.

[2]A. U. Desjardins: The Status of Radiology. Jour. Am. Med. Assn., May 23, 1931, XCVI, 1749-1753.

number of teachers can be increased only by such a break.

Besides developing full-fledged specialists, however, the scheme of instruction should also include short courses in the different phases of diagnostic and therapeutic radiology. This would satisfy a widespread demand, would spread the knowledge of advanced methods, and would tend to raise the general level of radiologic practice.

A well-considered scheme of instruction, therefore, should provide:

1. Short, strictly post-graduate, courses in different phases of diagnostic and therapeutic radiology for graduate physicians who may merely wish to keep informed on the value of various new methods or to prepare themselves to utilize one or another phase of radiology, and also for radiologists who may want to keep abreast of the newer technical developments and methods.

2. A comprehensive, graduate course of systematic and thorough instruction in every phase of radiology for physicians who desire to qualify as specialists.

The short courses should be open to any graduate physician, regardless of the character of his practice. This suggestion will no doubt be objected to by some, who may feel that to allow any physician to take such courses must result in encouraging physicians in general to conduct roentgenologic procedures or radiotherapy for themselves and in restricting the field of the radiologic specialist. This objection, I am convinced, is not strong. Although it must be conceded that the broad privilege of taking short courses would undoubtedly lead an increasing number of physicians to interest themselves in radiology and perhaps to employ it in their own work, I feel certain that, instead of limiting the field of the specialist, it would extend it. The more widespread the realization of the usefulness of different phases of radiology, the greater the likelihood that the real value of highly qualified specialists will receive the recognition it deserves. Certainly, it cannot be said that the short post-graduate courses in ophthalmology have lowered the level of ophthalmologic practice as a whole; on the contrary, they have led an increasing number of physicians to recognize the importance of high grade ophthalmology, and the status of this branch of medicine has risen as the number of qualified specialists has increased. To be sure, it would be fallacious to assume that this achievement has resulted from the provision of short post-graduate courses; the point is that such short courses do not appear to have acted as a deterring factor, and there are reasons for thinking that they have had an opposite effect. Therefore, the fear that short courses of instruction in radiology for graduate physicians may interfere with the general program of placing the post-graduate teaching and practice of radiology on a higher plane seems unwarranted.

Among the subjects in which short courses might well be provided are:

Physics of roentgen rays.
Physics of radium.
The quantitative and qualitative measurement of roentgen rays and radium.
Roentgenologic technic.
Roentgenologic interpretation.
Roentgenologic diagnosis of diseases of bones and joints.
Roentgenologic diagnosis of diseases of the respiratory tract.
Roentgenologic diagnosis of diseases of the gastro-intestinal tract.
Roentgenologic diagnosis of diseases of the urinary tract.
Roentgenologic localization of foreign bodies.
The newer methods of roentgenologic diagnosis.
The biologic principles of radiotherapy.
The technic of roentgen therapy.
The technic of radium therapy.

Physicians taking such courses should be entitled only to a certificate of attendance and should not be required to pass any

examination, unless the number of short courses taken is sufficient to enable them to qualify as specialists. In this event, they should be allowed to take a comprehensive examination, and, if they succeed in passing it, they should be entitled to a certificate and to the title of specialist. The courses should be arranged so as to crowd as much information as possible in the time allowed and should consist of both didactic and laboratory exercises or practical work. The aim of the lectures should be to set forth principles and to explain their application, so that those who take such courses may be able to solve their own problems by analyzing the factors involved and applying fundamental laws. Neither didactic nor practical instruction alone can serve the purpose. Laboratory exercises should be chiefly in the form of demonstrations, because to expect the average short-course student to derive much information from being allowed to fuss and stew in a laboratory for two hours a day for six weeks would be likely to prove a delusion. Often it would only serve to waste the time of the student and of the instructor. In general, a well conducted demonstration would be much more effective. In certain courses, however, in which it is essential for the student to familiarize himself with technical procedures or with the operation of measuring or other instruments, individual practice under the supervision of the instructor is essential.

COMPREHENSIVE GRADUATE COURSE

The comprehensive course leading to a degree such as that of Master of Science in Radiology or Doctor of Radiology should be conceived along the broadest possible lines. It is difficult to see how anything like a thorough course of instruction can be compressed into less than three years. Any attempt to effect undue compression must necessarily result in sacrificing thoroughness and, therefore, quality.

To insure that candidates may be able to take full advantage of the course, they should be subjected to reasonably rigid requirements, as far as antecedent instruction or training is concerned. The privilege of registration should be restricted to graduates of Class A schools and preference in selection should be given, or selection should be limited to those who have had, as part of their pre-medical training, college courses in physics and biology or their equivalent. An internship of at least one year in a Class A hospital should also be required as a preliminary to registration.

The first year of the graduate course should be devoted to anatomy, physiology, and pathology and to the physical aspects of radiology. One-half year of concentrated training in anatomy, physiology, pathologic anatomy (otherwise known as gross pathology), and microscopic pathology would provide the strongest possible foundation for both roentgenologic diagnosis and radiotherapy. A radiologist cannot possibly have too much knowledge of anatomy and pathology. Ability in roentgenologic interpretation depends in about equal measure on knowledge of anatomy and pathology, and these subjects are about equally important for roentgen and radium therapy. To meet the needs of roentgenologic diagnosis, instruction in anatomy should lay particular stress on landmarks and relations of special importance in roentgenology and on the developmental phases of bones. Physiology should be taught chiefly in the form of a review, but special attention should be given to the more significant radiologic considerations.

The second half of the first year should be given over to radiologic physics, instruction in which should include both didactic lectures and laboratory exercises. The lectures or conferences should be as practical as possible and should be planned so as to explain and demonstrate physical principles

as they apply to different phases of radiology. As much as may be feasible, examples should be selected from material related to that subject, and demonstrations should be arranged in the same way. The object of the laboratory exercises should be to serve as additional demonstration of principles, to explain the construction and operation of apparatus, and to familiarize the student with physical methods and instruments for measuring electrical potential and resistance, the quality and quantity of roentgen rays, and all other measurable factors that enter into the scientific practice of radiology.

The second year should be fully taken up by diagnostic roentgenology. Not only should the students be taught how to interpret roentgenograms, but they should be required to spend a good part of their time in performing, under the guidance and supervision of qualified instructors, the numerous technical procedures incidental to the present-day practice of diagnostic roentgenology. To watch some one else and to do things oneself are two quite different things. The one may be a useful preliminary to the other, but in no way can the former be regarded as a substitute for the latter. One who has not become thoroughly familiar with every step of a procedure by actual experience can never be in a position to direct subordinates intelligently. By every possible means, therefore, students should be induced to regard themselves as working members of the department in which they are receiving instruction and should be made to feel some measure of responsibility for whatever work they may be engaged in. This is the only way by which any one can expect to become really proficient. Roentgenography and roentgenoscopy have become so important that familiarity with every phase of their utilization in the diagnosis of diseases of bones and joints, of the digestive, respiratory and urinary tracts, of the nervous system, and also for the recognition and localization of foreign bodies, requires a detailed knowledge of many methods and of the variations in technic by means of which maximal information can be elicited under different circumstances. To become proficient in every detail of roentgenologic diagnosis in one year does not allow any time for frivolity. The question is, is one year really sufficient? Certainly, it can be accomplished only by careful planning and correlation and by the utmost economy of time.

Perhaps the foregoing results can best be achieved by arranging for the students to concentrate their attention, for periods of two or three months, on the roentgenologic procedures involved in the diagnosis of lesions affecting each of the groups of structures or organs previously mentioned. However, a fixed schedule is out of the question, because considerable latitude must be allowed in adjusting the details of the scheme of instruction to the circumstances of the institution in which the course is given. Besides instruction and practical training in roentgenography and roentgenoscopy, the students should be taught the photographic and chemical aspects of roentgenography and the methods of protection required for the safe practice of radiology.

Throughout this part of the course it is desirable that contact with clinical medicine and surgery be maintained. In some institutions the diagnostic roentgenologist may be obliged to work with little knowledge of the clinical features of the cases examined. At best, this is to be regarded as an unfortunate necessity, but never should it be looked on as an ideal. On the contrary, the closer the relations between medical or surgical clinicians and the roentgenologist, and the more knowledge the latter may have concerning the cases he examines, the more valuable should be his opinion.

The third year should be given over to

therapeutic radiology, including roentgen rays, radium and, if possible, ultra-violet radiation. The field of radiotherapy, once so restricted, is now rapidly extending, and every radiologist worthy of the name should receive as broad and as thorough training in the therapeutic as in the diagnostic aspect of this branch of medicine. The conspicuous and widespread lack of such training, and of the clinical and pathologic foundations on which it rests, are among the most glaring deficiencies of present-day American medicine. Owing to the general neglect of this phase of the subject, but chiefly because of the lack of qualified instructors, few institutions are now in position to undertake such teaching. If this deficiency is to be corrected, a beginning must be made. For a time it may even be necessary for two or more institutions to pool their facilities and personnel.

Students should be required to take an active part in the examination of patients, in outlining their treatment and in preparing patients for irradiation, as well as in the actual administration of the treatment. I should be quite feasible to arrange the work so that, without any transfer of responsibility from those on whom the professional and legal obligations actually devolve, the students may yet have an appreciable share in all phases of such treatment. Only through some such scheme can they be made to realize the significance of many details, careful consideration of which and attention to which spell the difference between superior and inferior treatment. Too often the medical side of radiotherapy is neglected and the physical aspects are over-emphasized. Both should receive due consideration. Important as it is to know the quantity and quality of radiation most useful in dealing with different pathologic conditions, it is even more important to be able to recognize the disease at different stages, to ascertain the extent of the primary lesion and of secondary foci, to size up the general state of the patient, and to adjust the treatment accordingly. Needless to say, the instruction in therapeutic radiology must be delegated to instructors of broad medical and radiologic experience. It may be contended that the general clinical, pathologic, dermatologic, surgical, gynecologic and other aspects of radiotherapy should be presented by specialists in the respective branches. But considerable difficulty may be encountered in finding specialists who have had sufficient experience with the radiologic aspects of their subject to qualify them for the task. To mention another example, few pathologists, and only a slightly greater number of practising radiologists, know much about the relative radiosensitiveness of different varieties of cells and tissues. To be sure, the subject is still comparatively new, but, unless a start is made, such knowledge as we possess will be slow to diffuse.

On the whole, the most feasible arrangement at the outset will probably be to delegate the general teaching of the subject to the most experienced and the best informed therapeutic radiologist available. He, in turn, should arrange to have those phases of the subject with which he is not sufficiently familiar presented by qualified specialists. The strictly radiologic teaching should be supplemented by lectures on related aspects of clinical medicine, surgery, and dermatology. Here again the need of combined didactic and practical teaching must be emphasized. This can be accomplished by means of lectures, but another effective, supplementary method is that of conferences or seminars at which certain of the students present a general review of some phase of the subject, which is then discussed by the instructor and by the other students.

The scope of roentgen therapy is distinctly broader than that of radium therapy, in that a wider variety of cutaneous, inflammatory, and neoplastic diseases are amenable

to treatment with roentgen rays than with radium. It must not be inferred, however, that the former subject should be allowed a greater proportion of time than the latter. An approximately equal period should be allotted to the two subjects. The therapeutic use of radium involves physical, clinical, and often surgical considerations, in which adequate knowledge, experience and judgment cannot be acquired hurriedly.

The program which I have ventured to outline would not be complete without the additional condition that, as part of his training, each graduate student should be required to undertake a piece of research on some phase of diagnostic or therapeutic radiology and to prepare a report or thesis based on such work. It is true that some, who may be brilliant in the practical aspects of radiology, may not shine as investigators. The value of the research requirement does not lie so much in the actual results obtained as in making the student realize the importance of careful work and in the discipline which may cause him to realize that, even after an extensive course of study, he does not know everything.

I am aware that such a sketchy outline may be unsatisfactory and that some would undoubtedly prefer a more detailed plan. I have deliberately avoided this, however, because the conditions at each institution, and the personnel and facilities available, vary so much that the details of any scheme of instruction must be worked out by those who are familiar with the requirements on the one hand and with the local conditions on the other.

X-rays Most Destructive to Young, Growing Cells.—X-rays in sufficient doses are destructive to all kinds of living cells, but they are most so to cells that are physiologically young and active. This is one of the basic physiological facts that underlie radiotherapy, Dr. Arthur U. Desjardins said in speaking before the American Association for the Advancement of Science. It follows from this principle that tissues that remain "chronically young" respond to X-ray dosages much smaller than those needed for effect on maturer tissues.

The most sensitive of all the cells in the human body are certain classes of white blood corpuscles, and the glands and other tissue masses where these are found most thickly are also very sensitive to the destructive rays. Dr. Desjardins inclines to the opinion that the easy destructibility of these white blood cells is at the bottom of the value of X-ray therapy in certain inflammatory conditions. White blood corpuscles crowd around foci of infection, causing inflammation. The X-rays break them down, releasing the germ-destroying substances they have formed within themselves, and thereby hasten the death of the trouble-causing bacteria.—*Science Service.*

A STATISTICAL STUDY OF RADIOLOGIC TEACHING IN THE MEDICAL SCHOOLS OF THE UNITED STATES AND CANADA

By LEON J. MENVILLE, M.D., F.A.C.R., NEW ORLEANS

A REVIEW of the radiologic literature reveals many interesting articles appertaining to a lack of proper understanding by a certain number of clinicians and surgeons of the limitations of and indications for the roentgen ray and radium in the diagnosis and treatment of disease. It would appear from current reports that this misconception of radiology is widespread; that it is not restricted to the rural districts, but is evident as well in large medical centers.

Years ago, when little was known concerning the roentgen ray and radium, it was to be expected that few physicians, except those specializing in radiology, would have other than a little practical medical knowledge of these agencies. In recent years, the progress of radiology has attracted the attention of the medical world: its scientific achievements fill pages in the medical literature. The result is that this literature offers a splendid opportunity to all its readers to become acquainted with the fundamentals of radiology, so that there should be no excuse for the modern, progressive physician to be ignorant of the limitations of and indications for radiology in its application to medicine.

In spite of the many advantages which organized medicine offers its members, only a certain number avail themselves of this opportunity. Many will continue to grope in the dark, as mind-blind physicians, without the faintest conception of just what a radiologist really is. They are unable to differentiate between a radiologist and a physician who manipulates an X-ray apparatus. In fact, many physicians believe that roentgenologic diagnoses are not necessarily the result of skill or a knowledge of medicine. Their understanding is that the roentgenological examination is purely the result of mechanical apparatus so standardized that anyone familiar with its operation can and does make correct diagnoses. We have all experienced the embarrassment of having to refuse to make certain impossible roentgenologic examinations at the request of a referring physician, and likewise to decline the treatment of certain diseases not amenable to radiation therapy. For instance, a radiologist was requested to measure in inches the length and width of the mitral valve of a patient's heart, and when the referring physician was informed that the radiologist was incapable of performing such an examination, the physician became indignant, saying that he would refer his patient to someone who could. He did, but not to a radiologist—to a physician friend who owned an X-ray machine. In this connection, however, there are many physicians who have acquired a substantial knowledge of the importance of radiology in medicine, and frequently consult with the radiologist in the same manner as with the surgeon and other specialists.

It is not difficult to ascertain the reason for the existence of this general confusion, which, of course, is due to a lack of radiologic education. It must be remembered that many of these physicians attended medical school at a time when little was known about the roentgen ray and radium. The medical curriculum then allocated but very little, if any, time to radiology; consequently early medical graduates who have not kept in touch with the development of this branch have but a vague conception of it. It is unfortunate that such physicians must continue to be deluded by the false

TABLE I.—QUESTIONS 1 TO 7, INCLUSIVE

School and Location (Alphabetical by States)	How many hours of didactic lectures are given in the following classes?				Have you a Department of Radiology?	What title is given to the Head of the Radiological Department?	Is the radiological teaching separate, or is it given in the Department of Medicine or Surgery?
	Freshman	Sophomore	Junior	Senior			
University of Alabama School of Medicine, University, Ala.	0	0					
College of Medical Evangelists, Los Angeles, Calif.	0	0	13	0	As part of Medicine	Prof. of Med.	Medicine, in didactic and practical classes
University of Southern California School of Medicine, Los Angeles, Calif.	0	0	18	0	As part of Medicine	Assoc. Clinical Prof. of Med. (Radiology)	Clinically combined with medicine and surgery
Stanford University School of Medicine, San Francisco, Calif.	0	11	0	0	As part of Medicine	Prof. of Med. (Radiology)	About half combined clinic, rest independent
University of California School of Medicine, San Francisco, Calif.	0	0			Yes	Clinical Prof. of Roentgenology	Sub. Dept. of Surgery
University of Colorado School of Medicine, Denver, Colo.	5	0	5	15	Division of Surgery	Chief of Div. of Radiology	With surgery
Yale University School of Medicine, New Haven, Conn.	0	0	12	60 elective clinical	Division of Medicine	Clinical Prof. of Radiology	Combined with medicine
Georgetown University School of Medicine, Washington, D. C.	0	0	15	0	Yes	Prof. of Roentgenology	Sub. Dept. of Surgery
George Washington University Medical School, Washington, D. C.			16	42 C	Yes	Prof. of Radiology	Separate
Howard University School of Medicine, Washington, D. C.	0	0	22	0	No		With surgery
Emory University School of Medicine, Atlanta, Ga.	0	0	45	8	Yes	Asst. Prof. of Clinical Surgery	Division of Surgery
University of Georgia Medical Department, Augusta, Ga.	0	0	0	36	Yes	Prof. of Clinical Radiology	Separate
Loyola University School of Medicine, Chicago, Ill.	0	0	48	0	No		Medicine
University of Chicago Graduate School of Medicine, Division of Biological Science, Chicago, Ill.	0	0	0	22	Division	Prof. of Roentgenology	Professor listed in Dept. of Medicine
University of Chicago, Rush Medical College, Chicago, Ill.	0	0	Elective 27 3 EC	27 3 EC	Yes	Assoc. Clin. Prof. of Surgery (Radiology)	Separate

C = Clinical; EC = elective clinical.

Of what importance is the teaching of radiology considered in your school?	Do you believe that more time should be given to radiology in medical schools?	Do you consider radiology of sufficient importance to be recognized on a parity with otolaryngology, dermatology, and ophthalmology?	Remarks
			Gives only first two years of medical course. One hour of second semester of Sophomore year given to introductory talk on radiology.
Very important in diagnosis, plate reading, and general principles of X-ray therapy, but not to be taught as a technical specialty.	Yes	Not equal to them	Twelve hours is given to the reading of X-ray films.
Considered important.	No	Yes, and rather more time is given to it than these specialties	In first semester of Junior year, one hour a week is spent in radiologic conference under the Dept. of Medicine, this centering around radiographic records of patients. We begin X-ray instruction in Anatomy and Physiology. With undergraduates, I believe radiology should be stressed for diagnosis and treatment.
Important. Professors of medicine and surgery attend combined clinic (weekly). Ninety per cent of students elect optional courses.	Not as a separate course	Yes	
The utmost, but as a tool of medicine and surgery.	No	No	
Very important.	Yes	Yes	
			In elective course, students spend about 60 hours in the department. In addition, conferences are held each week of the 6 weeks' course. Often students spend 12, instead of 6, weeks in the department.
Of considerable value in diagnosis and as a therapy.	Undergraduate: no	With otolaryngology and ophthalmology, yes	
Of major importance.	No	Yes	Six hours each in first 2 years given as radiologic anatomy. Forty-two hours in the fourth year spent in clinics.
Very necessary and should be a separate department.	Yes	Yes	
Of very great importance.	See remarks	Clinically, yes	Roentgenology utilized in all clinical departments for diagnostic and observation purposes. It has become almost indispensable in clinical teaching and practice.
Very valuable as diagnostic aid and every student should appreciate it.	No	No	While radiologic teaching is given separately, X-ray films and reports are used in the instruction given in the Departments of Medicine and Surgery.
Important.	No		
Essential.	Yes		The teaching is given in a conjoint course offered by several departments in co-operation.
It is an elective subject.	Yes	Yes	Junior and Senior students only at this college. An elective course, lecture, is given for 2 hours a week throughout the quarter and three quarters a year. The radiologist has ward-walk students for 6 hours.

School and Location (Alphabetical by States)	How many hours of didactic lectures are given in the following classes?				Have you a Department of Radiology?	What title is given to the Head of the Radiological Department?	Is the radiological teaching separate, or is it given in the Department of Medicine or Surgery?
	Freshman	Sophomore	Junior	Senior			
University of Illinois College of Medicine, Chicago, Ill.	0	0	0	12 C 32	No	Prof. of Radiology	Separate
Northwestern University Medical School, Chicago, Ill.	0	0	0	40 33	Yes	Prof. of Radiology	Separate
Indiana University School of Medicine, Indianapolis, Ind.	0	0		22	No	Assoc. Prof. of Roentgenology	Medicine
State University of Iowa College of Medicine, Iowa City, Iowa	No set number of hours				Yes	Assoc. Prof. of Roentgenology	With surgery, medicine, therapy
University of Kansas School of Medicine, Kansas City, Kans.	0	0	8	16	Yes	Asst. Prof.	Separate
University of Louisville School of Medicine, Louisville, Ky.	0	0	16	16 E	Yes	Instructor in Radiology	With surgery
Tulane University of Louisiana School of Medicine, New Orleans	0	0	6	6	No	Asst. Prof. of Medicine and Roentgenology	Medicine
Johns Hopkins University School of Medicine, Baltimore, Md.	0	0	8 C	8 C	No	Prof. of Chem. Roentgenology	Surgery
University of Maryland School of Medicine, Baltimore, Md.	0	0	0	36	Yes	Prof. of Roentgenology	Surgery
Boston University School of Medicine, Boston, Mass.	0	0	10	10	No	Asst. Prof.	In medicine and surgery
Harvard University Medical School, Boston, Mass.	0	0	6	0	No	Clin. Prof.	Medicine
Tufts College Medical School, Boston, Mass.	0	18	12		Yes	Prof. of Radiology	Separate
University of Michigan Medical School, Ann Arbor, Mich.	0	0	30	0	Yes	Prof. of Roentgenology	Separate
Detroit College of Medicine and Surgery, Detroit, Mich.	0	0	12	12	Yes	Prof. of Roentgenology	Separate
University of Minnesota Medical School, Minneapolis, Minn.			33	11	Yes	Prof.	Separate
University of Mississippi School of Medicine, Oxford, Miss.					No		With medicine and surgery
St. Louis University School of Medicine, St. Louis, Mo.	0	0	32	Demonstration	Yes	Prof. and Director Radiology	Separate
Washington University School of Medicine, St. Louis, Mo.	0	0	0	0	Yes	Prof. of Radiology	Both

C = clinical; E = elective.

Of what importance is the teaching of radiology considered in your school?	Do you believe that more time should be given to radiology in medical schools?	Do you consider radiology of sufficient importance to be recognized on a parity with otolaryngology, dermatology, and ophthalmology?	Remarks
Of great importance.	No	Yes	Students also receive 12 hours' instruction in the dispensary, examining and interpreting radiograms.
Of much importance.	Impossible at present	No	
Of great importance.	Yes	Yes	The radiologic instruction in the Junior year is incidental to clinical work by clinicians.
Same as for other laboratory work in diagnosis and therapy.	Not a great deal more	Not on a parity but as adjunct	
	No	Yes	
	No	Yes	
It is considered of definite importance.	In some, more; in others, not	Yes	
Two hours demonstration weekly for 8 weeks.	No	No	
Of the utmost importance.	Yes	Yes	
Quite important.	No	Depends on personnel of department	In the Senior year 10 hours are given in sections and work in all clinical subjects.
	Yes		In the Junior year 4 hours are given by courtesy of the medical staff. There should be instruction in normal X-ray anatomy during the first and second years.
	Yes	Yes	In the Junior year, the work is clinical; in the Senior year, the course is elective. Elective one month's course.
Very. All students follow every film of every patient assigned to them.	Yes	Yes	Also 32 section hours.
Highly important.	If practicable	Yes	The work in radiology is supplemented by practical work in connection with medicine and surgery.
Very important.	No	Yes	The professor of radiology offers an elective in X-ray anatomy for Freshmen and Sophomores, scheduled among the anatomy classes. The department participates in the medicine, surgery, etc., courses and offers electives.
Its importance begins in the Sophomore year.	No	Not before Junior year	Only the first two years of the medical course are given. Physicians and surgeons demonstrate X-ray films to the classes.
On equal basis with other subjects according to semester hours.	Possibly more than some give	Yes, we are doing just that	In the Junior year, the course consists of lectures, demonstrations, and quizzes.
First.	Yes; however, do not see how more time can be found	Yes	Here there is little didactic teaching of any subject.

School and Location (Alphabetical by States)	How many hours of didactic lectures are given in the following classes?				Have you a Department of Radiology?	What title is given to the Head of the Radiological Department?	Is the radiological teaching separate, or is it given in the Department of Medicine or Surgery?
	Freshman	Sophomore	Junior	Senior			
Creighton University School of Medicine, Omaha, Neb.	0	0	16		Yes	Prof.	Surgery
University of Nebraska College of Medicine, Omaha, Neb.	0	0	34	16	Yes	Full Prof.	Separate
Albany Medical College, Albany, N. Y.	1	10	22 8 C	36 C	No	Clin. Prof. Roentgenology	With surgery
Long Island College Hospital, Brooklyn, N. Y.					No	Prof. Clin. Radiology	With medicine
University of Buffalo School of Medicine, Buffalo, N. Y.	0	0	0	0	No		With medicine
Columbia University College of Physicians and Surgeons, New York, N. Y.	0	0	8	16	No	Assoc. Prof. of Medicine	With medicine
Cornell University Medical College, New York, N. Y.	0	10	31	Elective	Yes	Prof. of Radiology	With medicine and surgery
New York University, New York, N. Y.	0	0	11 32 ST	25 E	Yes	Prof. of Roentgenology	Separate and in medicine, surgery and pediatrics
New York Homeopathic Medical College and Flower Hospital, New York, N. Y.	0	0	33	0	Yes		With surgery
University of Rochester School of Medicine, Rochester, N. Y.	0	0	32	32	Yes	Assoc. Prof. of Med.	In both
Syracuse University College of Medicine, Syracuse, N. Y.	2	0	0	60	Yes	Prof. Clin. Radiology Prof. of Radiological Research	Fundamentals separate
University of North Carolina School of Medicine, Chapel Hill, N. C.	0	0					
Duke Univ. School of Medicine, Durham, N. C.	See remarks				Yes	Assoc. Prof. Roentgenology	Medicine
University of No. Dakota School of Medicine, Grand Forks, N. D.							

C = clinical; ST = section teaching; E = elective.

Of what importance is the teaching of radiology considered in your school?	Do you believe that more time should be given to radiology in medical schools?	Do you consider radiology of sufficient importance to be recognized on a parity with otolaryngology, dermatology, and ophthalmology?	Remarks
An important adjunct to diagnosis and treatment.	Not as independent subject	Hardly	The practical work is in conjunction with surgery and medicine; the didactic, separate. In the Senior year, 11 hours are devoted to instruction in the departments at the hospitals.
Indispensable.	Not here	Yes	
Practically the same amount of teaching hours as allotted to specialties under surgery.	Yes	Yes	The Freshman instruction is in conjunction with the course in gross pathology; Sophomore, with topographic anatomy; 8 clinical hours are given to radiology in the Junior year, and 36 in the Senior year.
Important as diagnostic aid.	See remarks		No didactic lectures are given. Believe only such time should be given radiology as is necessary in teaching undergraduate methods of diagnosis.
Very essential.	See remarks		Enough time should be given to emphasize its importance as diagnostic aid and therapeutic agent. Also, radiology is an essential part of medical curriculum.
Great importance.	No	See remarks	The Junior work is demonstration; the Senior, half diagnosis and half interpretation of films. Radiology also included in every course in which X-ray is used in diagnosis.
Very important.	Not separated from clinical	Yes	
Of great importance.	More in some, less in others	I do not see how a comparison can be made	Here radiotherapy is a separate department. Therefore, here it would seem that roentgenology is taught as a diagnostic procedure and should rank as any other particular unit which teaches a special method of diagnosis, as clinical pathology or physical diagnosis. I do not see how it can be compared to otolaryngology, dermatology, or ophthalmology, these being structural divisions having their own problems of pathology, physiology, diagnosis, and treatment.
	Yes	Yes	
Of great importance if the therapeutic side is properly developed as well as the diagnostic.		Yes. It is more than parity here	The danger of radiology is that it tends to supplant direct physical examination and should not be allowed to do so.
	Not here	Depends on local situation and tendencies of particular school	
			Gives only the first two years of the medical course. No course in radiology is given.
Great.	Yes	Yes	No didactic lectures given in any subject. Junior and Senior students have 2 hours per week of X-ray clinics or demonstrations.
		No	Gives only the first two years of the medical course. Elective course in radiology given in physics.

School and Location (Alphabetical by States)	How many hours of didactic lectures are given in the following classes?				Have you a Department of Radiology?	What title is given to the Head of the Radiological Department?	Is the radiological teaching separate, or is it given in the Department of Medicine or Surgery?
	Freshman	Sophomore	Junior	Senior			
University of Cincinnati College of Medicine, Cincinnati, Ohio	0	0	0	16	Yes	Prof. of Radiology	Separate
Western Reserve School of Medicine, Cleveland, Ohio	0	0	16	0	No	Asst. Prof.	With surgery
Ohio State University College of Medicine, Columbus, Ohio					No		With surgery
University of Oklahoma School of Medicine, Oklahoma City, Okla.	0	0	0	18	Yes	Assoc. Prof. of Radiology	See remarks
University of Oregon Medical School, Portland, Ore.	0	0	33	0	Yes	Clin. Assoc. in Radiology	With medicine
Hahnemann Medical College of Philadelphia, Philadelphia, Pa.	4	4	32	6	Yes	Prof.	Medical and therapeutic
Jefferson Medical College of Philadelphia, Philadelphia, Pa.	2 C	0	20	6 C	Yes	Prof. of Roentgenology	Separate
Temple University School of Medicine, Philadelphia, Pa.					Yes		
University of Pennsylvania School of Medicine, Philadelphia, Pa.	0	0	16	0	Yes	Prof.	Separate
Women's Medical College of Pennsylvania, Philadelphia, Pa.	0	8	0	15	Yes	Clin. Prof. of Radiology	Separate
University of Pittsburgh School of Medicine, Pittsburgh, Pa.	0	0	8	16	Yes	Prof. of Roentgenology	Separate
University of So. Dakota School of Medicine, Vermilion, S. D.	0	0					
University of Tennessee School of Medicine, Memphis, Tenn.	0	0	22	0	Yes	Assoc. Prof.	Separate
Meharry Medical College, Nashville, Tenn.	0	0	0	32	Yes		Separate
Vanderbilt University School of Medicine, Nashville, Tenn.	2	0	72	84	No	Asst. Prof. Clinical Surgery	Separate lectures
Baylor University College of Medicine, Dallas, Texas	0	0	0	32	No		With surgery
University of Texas School of Medicine, Galveston, Texas					Yes	Assoc. Prof.	Separate
University of Utah School of Medicine, Salt Lake City, Utah	0	11	0	0	No		

C = clinical.

Of what importance is the teaching of radiology considered in your school?	Do you believe that more time should be given to radiology in medical schools?	Do you consider radiology of sufficient importance to be recognized on a parity with otolaryngology, dermatology, and ophthalmology?	Remarks
It is a minor department.	Not here for undergraduate students	Yes	In connection with anatomy, Freshmen see fluoroscopic demonstrations; Juniors, in connection with dispensary work.
Great.	Only in conjunction with medical and surgical teaching	Yes	
Important branch of surgery.	Not with present crowded curriculum	No	No special course in radiology; it is given in regular work in surgery.
Considered an important part of the courses in medicine and surgery by hospital staff and faculty.	Not at our school	Not sure it would be considered so	In Senior year, 1 hour a week given to chest and 1 hour to gastro-intestinal. Patient examined under internist, then brought to X-ray department and physical signs and radiographic evidence correlated.
Great importance.	Probably	No	In all clinical departments, considerable attention given radiology, from diagnostic and therapeutic standpoints.
On an equal basis with physical diagnosis.	Yes	Yes	
Contributory.	No	Not quite	In Freshman year, 2 hours are given in conjunction with anatomy; in Sophomore year, 6 hours in laboratory.
Important.		Yes	
Great importance.	Probably not	I think so	Thirty hours of conferences included in medicine, surgery, pediatrics, neurology.
Of great importance but must be limited in hours to proportionate allotment of total curriculum time.		Radiology is not an isolated specialty	Students follow their ward cases through the X-ray department.
Of great importance.	No	Yes	
			Gives only the first two years of the medical course.
A minor, but required of all graduates.	No	Yes	
Of prime importance.		Yes	
Radiology ranks after general medicine, surgery, pediatrics, and gynecology, and rates above special branches.	Yes	Yes	All radiologic courses are elective, as tendency at this school is away from required courses.
Of great importance.	No	Not for undergraduate teaching	
An elective course here; only students averaging 80 for the first three years are allowed to take it.	Hope to make it required	I do	
Very little time given because we are only a two-year medical school.	Yes	No	

School and Location (Alphabetical by States)	How many hours of didactic lectures are given in the following classes?				Have you a Department of Radiology?	What title is given to the Head of the Radiological Department?	Is the radiological teaching separate, or is it given in the Department of Medicine or Surgery?
	Freshman	Sophomore	Junior	Senior			
University of Vermont College of Medicine, Burlington, Vt.	0	16	16	16	No		With medicine and surgery
University of Virginia Medical Department, Charlottesville, Va.	0	0	0	20	Yes	Assoc. Prof. of Roentgenology	Separate
Medical College of Virginia, Richmond, Va.	0	0	16	16	Yes	Prof.	Separate
West Virginia University School of Medicine, Morgantown, W. Va.							
University of Wisconsin Medical School, Madison, Wis.	0	0	16	Elective 10 C	Yes	Prof. of Radiology	Separate
Marquette University School of Medicine, Milwaukee, Wis.	0	0	16	16	No	Assoc. Clin. Prof. and Director of Division of Roentgenology	With surgery
CANADA							
University of Alberta, Edmonton, Canada	0	0	15	0	Sub. Dept.	Lecturer in Radiology	With medicine and surgery
University of Manitoba, Winnipeg, Canada	0	0	0	0	Sub. Dept.	Lecturer	With medicine
Dalhousie University, Halifax, Nova Scotia	0	0	4	0	No		With medicine
Queen's University, Kingston, Ontario, Canada	0	30	60	44	Yes	Prof.	Separate
University of Western Ontario Medical School, London, Ontario, Canada	0	0	30	15	Yes	Prof.	Separate
University of Toronto, Toronto, Ontario, Canada	0	0	5th year 15	6th year 40	Yes	Assoc. in Radiology	Separate and in both
McGill University, Montreal, Quebec, Canada	0	0	5 C	10 5th year 10 10 C	Yes	Lecturer	Both
University of Montreal Medical Faculty, Montreal, Canada							
Laval University Faculty of Medicine, Quebec, Canada	0	0	0	20	No		Separate
University of Saskatchewan, Saskatoon, Canada.							

C = clinical.

?

Of what importance is the teaching of radiology considered in your school?	Do you believe that more time should be given to radiology in medical schools?	Do you consider radiology of sufficient importance to be recognized on a parity with otolaryngology, dermatology, and ophthalmology?	Remarks
Minor special subject.	No	No	
Of great importance, but we are not trying to train undergraduates to be practical radiologists.	No	Dealt with here departmentally like specialties	
Minor department.	No	About the same	
			Gives only the first two years of the medical course.
As important as that of any other specialty.	Yes	Yes	Seniors get group teaching and also optional seminar in radiology.
An important factor in diagnosis and same in treatment.	Hard to find more time	All of these subjects are post-graduate, except a general knowledge	
Considerable importance.	Only in accordance with needs of other subjects	Almost, as undergraduate subject	
Not a major subject as yet.	Yes	Its importance is stressed in all courses	
Of much importance.	No	No	The lectures are supplemented by individual instruction in X-ray rooms.
Very important.	No	Yes	
A minor course.			
Elementary course highly important.		No	
Important for training specialists in graduate work and students in reading fluoroscopic films and plates.		No	In Junior year, 5 demonstrations are given; in the fifth year, 10 practical demonstrations and 10 lectures and slides.
A separate and serious element.			In first and second years, 20 hours didactic and 40 hours laboratory work given in physiotherapy; in fourth year, 10 lectures in physiotherapy; in fifth year, series of lectures with demonstrations in radium and X-ray therapy.
Of general information without specializing of the student.	Only as general information	No	
			Gives only the first two years of the medical course.

TABLE II.—QUESTION 1

	No lectures or demonstrations elective or required						Schools not replying to questionnaire					
	Number replies			Percentage			Number			Percentage		
81 replies	U. S.	Canada	Both	U. S.	Canada	Both	U. S.	Canada	Both	U. S.	Canada	Both
Freshman	56	8	64	87	100	88	7	2	9	9.8	20	11
Sophomore	53	7	60	84	87	84	7	2	9	9.8	20	11
Junior	17	3	20	30	37	31	9	2	11	12.6	20	13
Senior	19	4	23	32	50	34	8	2	10	11.	20	12
5th year												
6th year												
Total, 4 years												
Total, 6 years												

TABLE III.—QUESTION 1

	Required class demonstrations, clinic demonstrations						Required clinic demonstration					
	Number			Percentage			Number of hours			Average		
	U. S.	Canada	Both	U. S.	Canada	Both	U. S.	Canada	Both	U. S.	Canada	Both
Freshman	1	0	1	1.5	0	1.3	2	0	2	2	0	2
Sophomore	0	0	0	0	0	0	0	0	0	0	0	0
Junior	2	1	3	3.1	12	4.2	16	5	21	8	5	7
Senior	6	0	6	10.3	0	9.0	104	0	104	17	0	17
5th year		1			12			10	10		10	
6th year												

TABLE IV.—QUESTION 1

	Elective clinic demonstration					Required courses, lectures and demonstration					
	Number schools	Percentage of schools	Number of hours	Average number hours	Average number hours all schools	Number schools			Percentage		
	U. S.	U. S.				U. S.	Canada	Both	U. S.	Canada	Both
Freshman	--	--	--	--	--	7	0	7	10.9	0	9.8
Sophomore	--	--	--	--	--	10	1	11	16	12.5	15
Junior	1	1.8	3	3	.05	42	5	47	76.3	62.5	74.6
Senior	4	6.8	89	22.2	1.5	35	4	39	60.3	50	59
5th year											
6th year											

Schools giving lectures required						Required number hours lectures			Required number hours, average each school			Required lectures average of all schools replying to questionnaire Hours		
Number			Percentage											
U. S.	Canada	Both	U. S.	Canada	Both	U. S.	Canada	Both	U. S.	Canada	Both	U. S.	Canada	Both
6	0	6	.9	0	.8	20	0	20	3.3	0	3.3	.3	0	.2
10	1	11	16	12	15	95	30	125	9.5	30	11.3	1.5	3.7	1.0
40	4	44	72	50	69	877	109	986	21.9	27.2	22.4	15.9	13.6	15.6
29	4	33	50	50	50	670	89	759	23.1	22.2	23.0	11.5	11.1	11.5
	2			25			25			12.5			3.1	
	1			12			40			40			5	
						1662	228	1890						
							293	1955						

(7 2-year schools)

Required clinic demonstration. Average of all schools replying to questionnaire Hours			Elective lectures. Number of schools			Elective lectures; percentage of schools	Elective lectures number of hours	Average number hours elective lectures	Average number hours elective all schools
U. S.	Canada	Both	U. S.	Canada	Both	U. S.	U. S.	U. S.	U. S.
.03	0	.028	1	0	1	1.5	....	....	....
0	0	0	1	0	1	1.6	....	....	....
.29	.6	.3	1	0	1	1.8	27	27	.48
1.8	0	1.6	6	0	6	10.3	108	18	1.8
	1.2								
							135		

Required number of hours Required lectures and demonstrations						Average for all schools			Schools giving elective lectures and clinic demonstrations	
Number			Average						Number	Percentage
U. S.	Canada	Both	U. S.	Canada	Both	U. S.	Canada	Both	U. S.	U. S.
22	0	22	3.1	0	3.1	.3	0	.3	1	1.5
95	30	125	9.5	30	11.3	1.5	3.7	1.8	1	1.5
893	114	1007	21	22.8	21.4	16.2	14	15.9	1	1.8
774	89	863	22.1	22.2	24.1	13.7	11	13	9	15.5

TABLE V.—QUESTION 1

	Number hours all elective courses	Average per school	Average all schools	Schools giving required and elective courses					
				Number			Percentage		
	U. S.			U. S.	Canada	Both	U. S.	Canada	Both
Freshman	....	....	....	8	0	8	12.5	0	11
Sophomore	....	....	....	11	1	12	17	12.5	16.9
Junior	30	30	.5	43	5	48	78.1	62.5	76.1
Senior	197	21.8	3.0	44	4	48	75.8	50	72.7
5th year									
6th year									
Total	227	51.8							

TABLE VI.—LECTURES, NUMBER OF HOURS, REQUIRED AND ELECTIVE (QUESTION 1)

	United States	Canada	Both
Freshman	20	0	20
Sophomore	95	30	125
Junior	904	109	1,013
Senior	778	89	867
5th year	0	25	25
6th year	0	40	40
Total 4 years	1,797	228	2,025
Total 6 years	1,797	293	2,090

TABLE VII.—CLASS DEMONSTRATIONS—NUMBER OF HOURS GIVEN IN BOTH ELECTIVE AND REQUIRED COURSES (QUESTION 1)

	United States	Canada	Both
Freshman	2	0	2
Sophomore	0	0	0
Junior	19	5	24
Senior	193	0	193
5th year	0	10	10
6th year	0	0	0
Total 4 years	214	15	229
Total 6 years	214	15	229

claims made for radiology. It would be a most distressing situation if such a condition should apply to the recent graduates of medicine, numbering thousands each year. The future correction of this evil lies in our

TABLE VIII.—QUESTION 2. HAVE YOU A DEPARTMENT OF RADIOLOGY?

		Percentage
United States (71 schools)		
No answer to question	5	7.0
Yes	41	62.1
No	25	37.9
Canada (10 schools)		
No answer to question	2	20.0
Yes	4	50.0
No	4	50.0
Total—United States and Canada—81 schools		
No answer to question	7	8.6
Yes	45	60.8
No	28	39.2

TABLE IX.—QUESTION 3. WHAT TITLE IS GIVEN TO THE HEAD OF THE RADIOLOGICAL DEPARTMENT?

		Percentage
United States		
Professor	35	63.6
Associate Professor	14	25.4
Assistant Professor	4	7.3
Instructor in Radiology	1	1.8
Canada		
Professor	2	33.3
Lecturer	3	50.0
Associate in Radiology	1	16.6
No answer to question	4	40.0

Hours in all courses						Average all schools		
Number			Average					
U. S.	Canada	Both	U. S.	Canada	Both	U. S.	Canada	Both
22	0	22	2.7	0	2.7	.3	0	.3
95	30	125	8.6	30	10.4	1.5	3.7	1.8
923	114	1037	21.4	22.8	21.6	16	14.2	16
971	89	1060	22	22	22	16.5	11.1	16
	35	35						
	40	40						
2011	308	2319						

TABLE X.—QUESTION 4. IS THE RADIOLOGICAL TEACHING SEPARATE, OR IS IT GIVEN IN THE DEPARTMENT OF MEDICINE OR SURGERY?

		Per-centage
United States (71 schools)		
No reply to question	7	9.8
Number of replies to question	64	90.2
Teaching separate	26	40.6
Medicine	14	21.8
Surgery	16	25.0
Medicine and surgery	8	12.5
Canada (10 schools)		
No reply to question	2	20.0
Teaching separate	2	25.0
Medicine	4	50.0
Surgery	0	0
Medicine and surgery	2	25.0

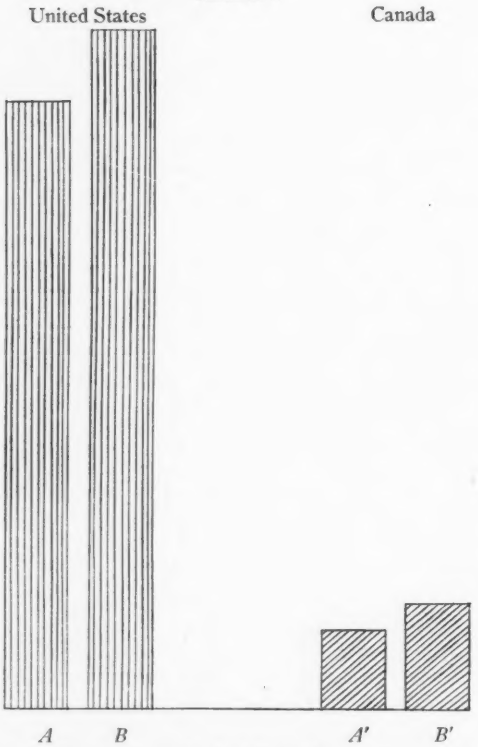
TABLE XI.—QUESTION 5. OF WHAT IMPORTANCE IS THE TEACHING OF RADIOLOGY CONSIDERED IN YOUR SCHOOL?

		Per-centage
United States		
No reply to question	14	19.7
Number of replies	57	80.3
Major, considerable, great importance	50	87.7
Minor department or minor importance	4	7.0
Elective	2	3.5
Contributory	1	1.7
Canada		
No reply to question	3	30.0
Number of replies	7	70.0
Major importance	5	71.4
Minor importance	2	28.5

medical schools, which have already made substantial advancement in radiologic education.

Recent graduates in medicine are well equipped with the medical knowledge and training in technic to practise medicine scientifically. Modern medical schools are usually sufficiently endowed to procure the best medical talent available as teachers, and are adequately equipped with laboratory facilities, all of which contributes to the education of the modern, scientific, and practical young doctor of to-day. Young doctors appreciate the necessity for years of application and study in order that they may become specialists in any branch of medicine. They are taught how to perform an operation for cataract, and even the enucleation of an eye, yet how many would be brave enough to perform these operations on private patients? They have been taught that such procedures are for the ophthalmologist, who is a specialist with years of

GRAPH I



A—Hours of required and elective lectures given in radiology in schools in U. S., 1,797.

B—Hours of required and elective lectures and class demonstration given in radiology in schools in U. S., 2,011.

A'—Hours of required and elective lectures given in radiology in Canadian schools, 228.

B'—Hours of required and elective lectures and class demonstration given in radiology in Canadian schools, 308.

TABLE XII.—QUESTION 6. DO YOU BELIEVE THAT MORE TIME SHOULD BE GIVEN TO RADIOLOGY IN MEDICAL SCHOOLS?

		Per-centage
United States		
No reply to question	16	22.8
Number of replies	54	77.2
Yes	23	42.5
No	31	57.5
Canada		
No reply to question	5	50.0
Number of replies	5	50.0
Yes	3	60.0
No	2	40.0

TABLE XIII.—QUESTION 7. DO YOU CONSIDER RADIOLOGY OF SUFFICIENT IMPORTANCE TO BE RECOGNIZED ON A PARITY WITH OTOLARYNGOLOGY, DERMATOLOGY, AND OPHTHALMOLOGY?

		Per-centage
United States		
Number of replies	55	78.6
No reply to question	15	21.4
Yes	40	72.7
No	15	27.3
Canada		
Number of replies	6	60.0
No reply to question	4	40.0
Yes	2	33.3
No	4	66.6

experience in eye diseases. A substantial course in radiology in our medical schools would have a like influence on students as in the instance just mentioned, and few would venture in the realm of radiology without sufficient knowledge and experience.

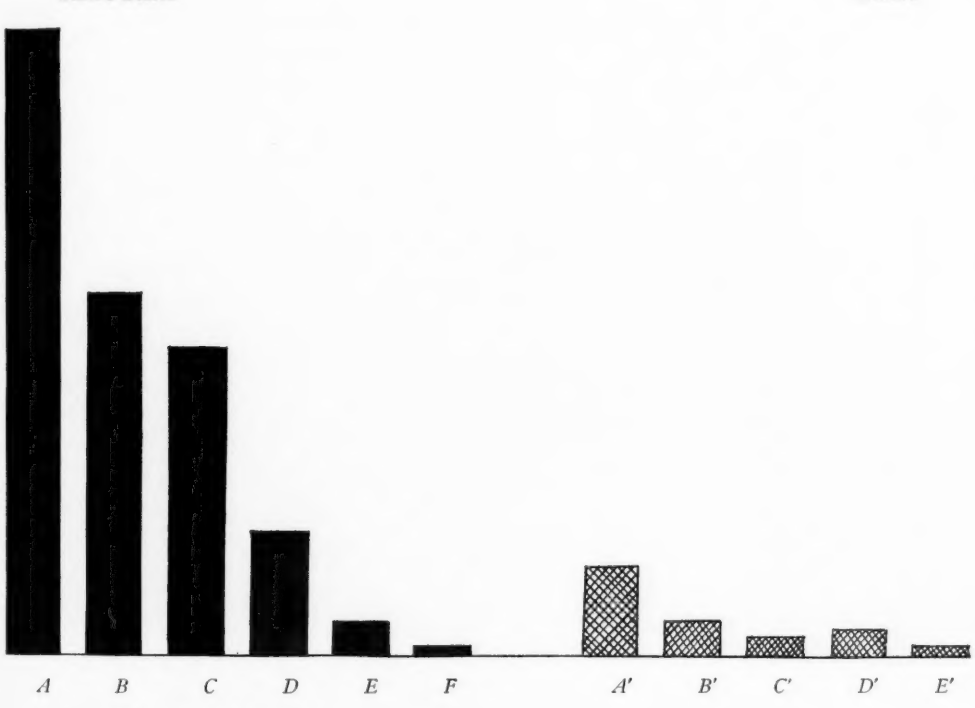
Radiologists have often wondered if the medical schools of this country are giving sufficient time to the teaching of radiology, so that their graduates will have acquired at least an intelligent and practical understanding of this subject.

While we have known for some time that certain schools were teaching students radiology, few of us knew the amount of time consumed and the different methods used. Very little information is available in this regard. Personally, I have known for some time that certain of our schools were giving a more substantial course in radiology than most of us thought. My attention was first attracted to this when, as a member of my State Board, I was asking questions pertaining to radiology. The answers received from the recent graduates indicated that, on the whole, they had an intelligent understanding of the application of the roentgen ray and radium; so much so, in fact, that I thought that more radiologic questions

should be asked by the various State Boards of Medical Examiners. But before agitating this question, I decided to ascertain the status of radiologic teaching in various medical schools. For this reason the following seven questions were sent each medical school of this country and Canada:

1. How many hours of didactic lectures are given in the following classes: Freshman, Sophomore, Junior, Senior?
2. Have you a Department of Radiology?
3. What title is given to the head of the Radiologic Department?
4. Is the radiologic teaching separate, or is it given in the Department of Medicine or Surgery?
5. Of what importance is the teaching of radiology considered in your school?
6. Do you believe that more time should be given to radiology in medical schools?
7. Do you consider radiology of sufficient

GRAPH 11



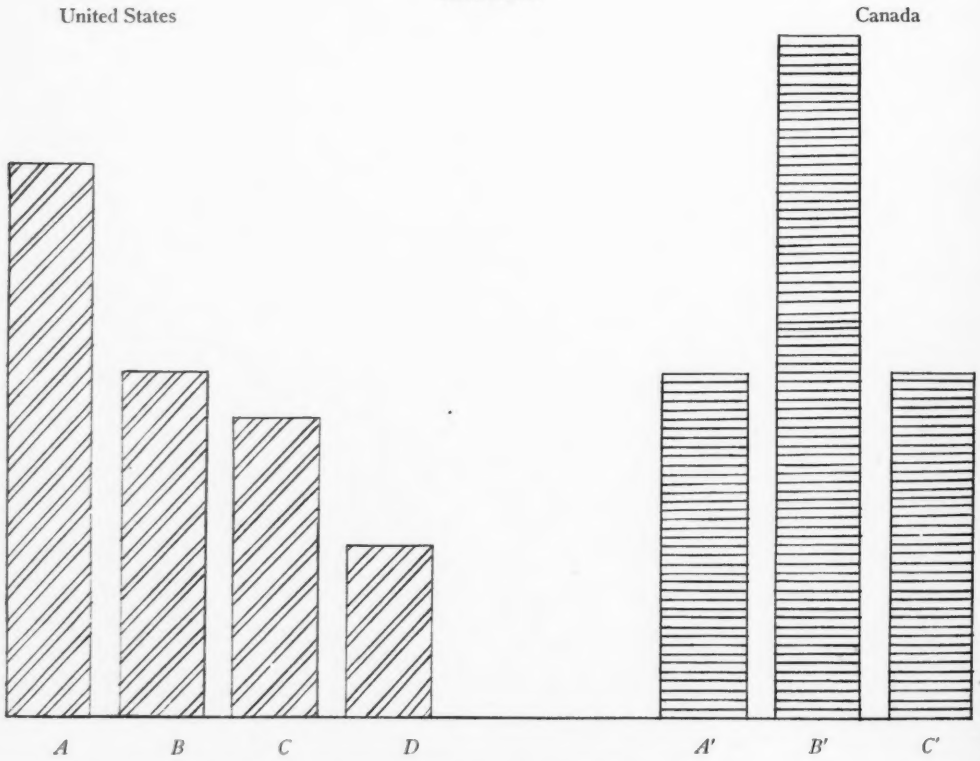
A—71 medical schools in U. S.
B—41 medical schools in U. S. have a Department of Radiology.
C—In 35 medical schools in U. S. the title of the Head of the Radiological Department is Professor.
D—In 14 medical schools in U. S. the title of the Head of the Radiological Department is Associate Professor.
E—In 4 medical schools in U. S. the title of the Head of the Radiological Department is Assistant Professor.
F—In 1 medical school in U. S. the title of the Head of the Radiological Department is Instructor in Radiology.
A'—10 Canadian medical schools.
B'—4 Canadian medical schools have a Department of Radiology.
C'—In 2 Canadian medical schools the title of the Head of the Radiological Department is Professor.
D'—In 3 Canadian medical schools the title of the Head of the Radiological Department is Lecturer.
E'—In 1 Canadian medical school the title of the Head of the Radiological Department is Associate in Radiology.

importance to be recognized on a parity with otolaryngology, dermatology, and ophthalmology?

The replies have been tabulated (Tables I-XIII) so that the information may appear in concise form, easy of analysis. Thirteen tables are presented, comprising the essential information derived from the questionnaire.

Table I presents the names of the different medical schools of the United States and Canada and their replies. Table II shows the number of schools which do not give lectures on radiology or clinic demonstrations, etc., the number which did not reply to Question 1, the number in which lectures are required, the number of hours of radiologic lectures, and the hours per school. Table III presents the number of schools in which clinic and class demonstrations are required; the hours allotted to each; an average of those requiring clinic demonstrations, and the number of hours of elective lectures. Table IV presents the number of schools and hours given to elective clinic demonstrations and to the required courses in lectures and demonstrations, also the number of schools giving elective lectures and clinic demonstrations. Table V lists the number of hours of required and elective lectures; Table VI the number of hours of

GRAPH III

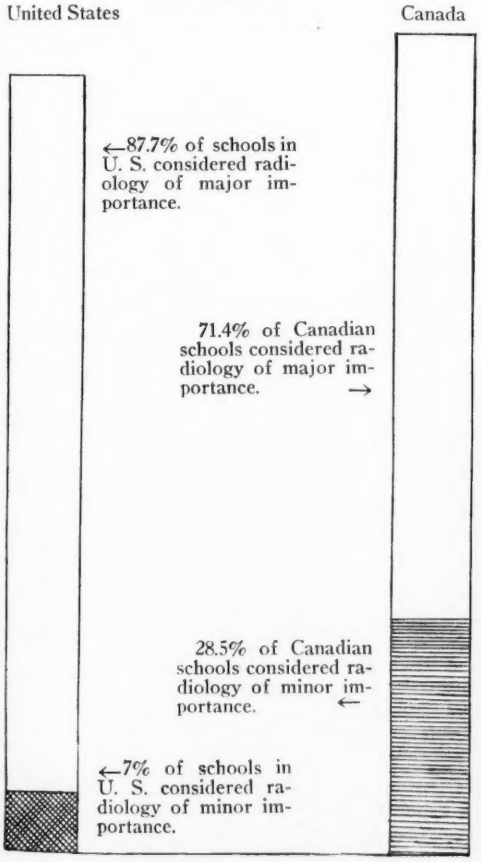


A—40.6% of schools in U. S. give separate radiological teaching.
B—25% of schools in U. S. teach radiology in the Department of Surgery.
C—21.8% of schools in U. S. teach radiology in the Department of Medicine.
D—12.5% of schools in U. S. teach radiology in the Departments of Medicine and Surgery.
A'—25% of Canadian schools give separate radiological teaching.
B'—50% of Canadian schools teach radiology in the Department of Medicine.
C'—25% of Canadian schools teach radiology in the Departments of Medicine and Surgery.

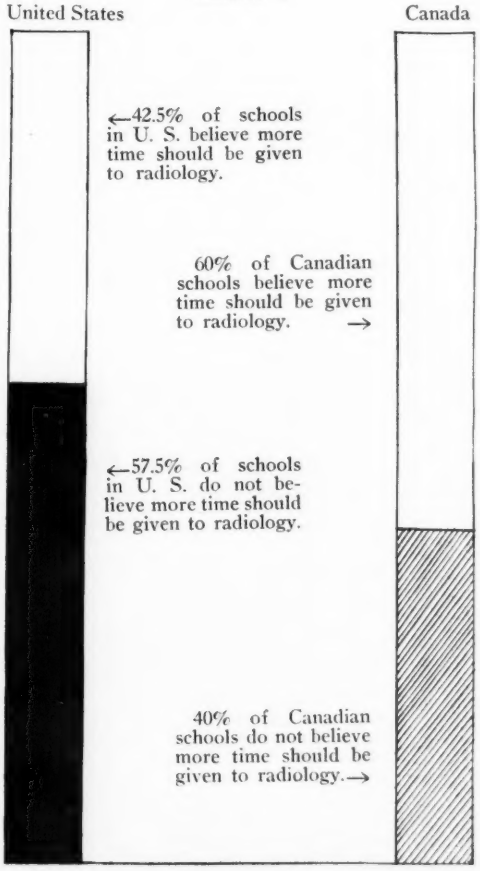
required and elective class demonstrations. Table VII shows the number of hours given in all elective courses, also the number of schools and hours giving required and elective courses. Tables VIII-XIII tabulate the replies to Questions 2-7 in percentages. Each of the 71 recognized medical schools of the United States and 10 Canadian schools answered the questionnaire. They did not, however, answer every question. The two-year schools answered only Question 1. Some of the answers to Question 1 are in Table II; the others are in Table VIII. (See also Graphs I-VI.)

In the Freshman year, six medical schools of this country give 20 hours, or 3.3 hours per school, to required radiologic lectures; in the Sophomore year, 10 schools give 95 hours, or 9.5 hours per school; in the Junior year, 40 schools give 877 hours, or 21.9 hours per school, and in the Senior year, 29 schools give 670 hours, or 23.1 hours per school. The Canadian schools do not give lectures in radiology in the Freshman year. One school gives 30 hours in the Sophomore year; 4 schools give 109 hours, or 27.2 hours per school, in the Junior year, and 4 schools give 89 hours, or 22.2 hours per school, in the Senior year. Besides this, two Canadian schools give 25 hours, or 12.5 hours per school, in the fifth year, and one school gives 40 hours in the sixth year. The total number of hours given to required radiologic lectures in the medical schools of

GRAPH IV


United States
Canada
←87.7% of schools in U. S. considered radiology of major importance.
71.4% of Canadian schools considered radiology of major importance. →
28.5% of Canadian schools considered radiology of minor importance. ←
←7% of schools in U. S. considered radiology of minor importance.

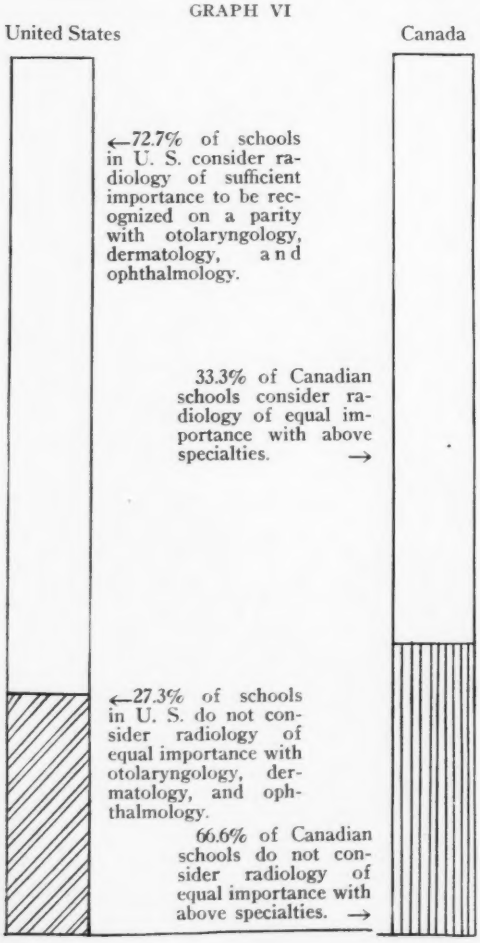
GRAPH V


United States
Canada
←42.5% of schools in U. S. believe more time should be given to radiology.
60% of Canadian schools believe more time should be given to radiology. →
←57.5% of schools in U. S. do not believe more time should be given to radiology.
40% of Canadian schools do not believe more time should be given to radiology. →

the United States is 1,662; in Canada, 293, which includes the fifth and sixth years. This makes a total for both countries of 1,955 hours. (See Graph I.)

Many different answers were received to Question 1. The answers appertaining to didactic lectures have already been tabulated. Those answering that they gave, in addition, required class and clinic demonstrations are found tabulated in Tables III and IV. Table V is a summary of Tables II, III, and IV. In Table V we find that 8 of our schools, or 12.5 per cent, gave required and elective courses in the Freshman year; 11, or 17 per cent, in the Sophomore year; 43, or 78.1 per cent, in the Junior year, and 44, or 75.8 per cent, in the Senior year. One school in Canada, or 12.5 per cent, gave required and elective courses in the Sophomore year; five schools, or 62.5 per cent, in the Junior year, and four, or 50 per cent, in the Senior year. The courses of required and elective periods in our Freshman year consisted of 22 hours, or 2.7 hours per school; 95 hours, or 8.6 hours per school, in the Sophomore year; 923 hours, or 21.4 hours per school, in the Junior year, and 971, or 22 hours per school, in the Senior year. In Canada none was given in the Freshman class; 30 hours per school in the Sophomore year; 114 hours, or 22.8 hours per school, in the Junior year, and 89, or 22 hours per school, in the Senior year. The total number of hours given in all elective courses in our medical schools is 227, or 21.8 hours for each school. The total hours devoted to radiologic teaching in schools in the United States is 2,011. In Canadian schools it is 308, a grand total of 2,319.

GRAPH VI


United States
Canada
←72.7% of schools in U. S. consider radiology of sufficient importance to be recognized on a parity with otolaryngology, dermatology, and ophthalmology.
33.3% of Canadian schools consider radiology of equal importance with above specialties. →
←27.3% of schools in U. S. do not consider radiology of equal importance with otolaryngology, dermatology, and ophthalmology.
66.6% of Canadian schools do not consider radiology of equal importance with above specialties. →

Question 2 (Table VIII) was answered by 66 of our schools. Of these, 41, or 62.1 per cent, stated they have a Department of Radiology; 25, or 37.9 per cent, do not. Of the Canadian schools, 8 answered the question; 4, or 50 per cent, have a Department of Radiology, and 4, or 50 per cent, do not. In the United States and Canada, 60.8 per cent of the schools maintain Departments of Radiology and 39.2 per cent do not. (See Graph II.)

Question 3 (Table IX) was answered by 54 of the schools in the United States and 6 in Canada. Of medical schools in the United States, 35, or 63.6 per cent, have Professors of Radiology; 14, or 25.4 per cent, Associate Professors; 4, or 7.3 per cent, have Assistant Professors, and 1, or 1.8 per cent, has Instructors. In Canada, 2 schools, or 33.3 per cent, have Professors; 3, or 50 per cent, have Lecturers, and 1 school, or

16.6 per cent, has an Associate in Radiology. (See Graph II.)

Question 4 (Table X) was answered by 64 American schools and 8 Canadian schools. Of these, 26, or 40.6 per cent, stated that radiology is being taught as a separate branch in the United States; 14, or 21.8 per cent, that it is being taught in the Department of Medicine; 16, or 25 per cent, in the Department of Surgery, and 8, or 12.5 per cent, in both Medicine and Surgery. In Canada, 2, or 25 per cent, teach radiology separately, 4, or 50 per cent, in the Department of Medicine, and 2, or 25 per cent, in both Surgery and Medicine. (See Graph III.)

Question 5 (Table XI) was answered by 57 American schools and 7 Canadian schools. In the United States, 50, or 87.7 per cent, consider the teaching of radiology as of major, considerable, or great importance; 4, or 7 per cent, consider the teaching of radiology as a minor department or of minor importance; 2, or 3.5 per cent, consider it as elective, and 1, or 1.7 per cent, as contributory. In Canada, 5, or 71.4 per cent, of the schools consider it as of major importance, and 2, or 28.5 per cent, consider it as of minor importance. (See Graph IV.)

Question 6 (Table XII) was answered by 54 schools in the United States and 5 in Canada. In the United States, 23, or 42.5 per cent, believe that more time should be given to radiology in medical schools, and 31, or 57.5 per cent, did not so believe. In Canadian schools, 3, or 60 per cent, believe that more time should be given to it, and 2, or 40 per cent, did not so believe. (See Graph V.)

Question 7 (Table XIII) was answered by 55 American and 6 Canadian schools. In the United States, 40, or 72.7 per cent, thought that radiology is of sufficient importance to be recognized on a parity with otolaryngology, dermatology, and ophthalmology, and 15, or 27.3 per cent, did not so believe; 2, or 33.3 per cent, of the Canadian schools believe it to be so, and 4, or 66.6 per cent, do not agree. (See Graph VI.)

World-wide Study of Cosmic Rays Begun.—A world-wide campaign for more knowledge about the little-understood cosmic radiation, whose rays are the most penetrating known, was begun when Dr. Arthur H. Compton, of the University of Chicago, noted physicist, left for Panama to start the first investigations.

In Panama Dr. Compton will climb Mt. Chico to measure the rays with a new instrument. He will then go to Huancayo in Peru, Mt. Cook in New Zealand, Mt. Kosciusko in Australia, Mauna Loa in Hawaii, and Mt. McKinley in Alaska. Mrs. Compton and a fourteen-year-old son, Arthur Alan, will accompany him on this trip around the world.

When Dr. Compton returns next Summer he will hear reports from three other parties, one of which will work in Patagonia and Chile, the second in South Africa, and the third in India, Ceylon, Straits Settlements, and Java. It is expected that tests at altitudes of 20,000 feet and higher will be made. Negotiations are also under way for observations in the polar regions.—*Science Service.*

RADIOLOGIC SERVICE IN THE UNITED STATES[1]

Report by the Council on Medical Education and Hospitals

The work of preparing a list of acceptable "radiologic laboratories and departments of radiology" was assigned to the Council on Medical Education and Hospitals by the House of Delegates at the Minneapolis session in 1928. The "Essentials" were prepared by the Council in collaboration with a large number of specialists in the field of radiology. Suitable questionnaires were prepared in the same manner and were mailed to all the physicians who were known to be engaged in the practice of radiology and roentgenology. The majority of the physicians so engaged returned their questionnaires and they were considered for the list. To assist the Council in preparing the list, the officials of the two leading radiologic societies co-operated with the Council's special committee by appointing qualified radiologists in all parts of the country to act as advisers. These advisers, numbering 198, examined the credentials of applicants from their respective localities, made inspections, and advised which candidates could qualify, according to the "Essentials." The resulting tentative list, together with a detailed report on the survey, was published in the Radiologic Number of *The Journal*, May 23, 1931.

Since various branches of medicine look to the radiologist for important aid in diagnosis and treatment, the careful certification of physicians qualified in radiology should be made to protect the patient and the profession. A powerful influence in the regulation of those qualified is, of course, membership in special radiologic societies. This membership immediately bars the lay practitioner and, to some extent, the physician who has not had adequate training and experience. Membership lists of the special societies include the names of many whose main interest lies in other specialties.

The Council has understood from the beginning and has advocated the principle that the practice of radiology is the practice of medicine. It has followed this principle in the interpretation of the essentials, in the preparation of its lists and in every opportunity that the Council has had to express itself on this point to the entire medical profession.

Emphasis Placed on Specialists

At first the emphasis was on laboratories and departments of radiology and roentgenology. Both the questionnaire and the "Essentials" laid stress on the laboratories, including equipment, personnel, records and publicity. The tentative list referred to laboratories or departments of radiology and roentgenology. But difficulties were found in the listing of laboratories as such, because laboratories change names; they also change directors and ownership, these changes often resulting in an entire change of methods and sometimes a reversal of ethical principles. It became apparent that the determining factor in radiologic service is the specialist who does the work or supervises it. Emphasis, therefore, was shifted from the laboratory to the directing radiologist, the main emphasis now being placed on his qualifications.

The "Essentials" have been recently revised to correspond with this new point of view, and the newly revised "Essentials," as adopted by the Council at its meeting in February, 1932, are printed in connection with this article.

How the List Is Compiled

The routine by which all applicants are admitted to the list is as follows:

[1]Reprinted by permission from the *Journal of the American Medical Association*, March 19, 1932, XCVIII.

1. A questionnaire is sent to all specialists in the field who, according to information, seem to have the necessary qualifications.

2. On receipt of the returned questionnaire, the record and credentials of the applicant are verified in the biographic file of the American Medical Association.

3. Each application is submitted to at least three or more advisers, who give their estimate and opinion of the qualifications of the applicant, based on personal knowledge or inspection, or both.

4. Membership in special societies is looked up, and the advice of the officers of those societies and the officers of county medical societies, and of councilors, is obtained.

In this way the principle is observed that specialists should be judged by specialists. Those who work and associate with specialists have the best opportunity of knowing them. Due attention is also given to the records in the biographic file of the American Medical Association and to the individual's own report on himself and his work.

The first survey covered mainly those radiologists who were conducting laboratories of their own and included, also, those who were connected with hospitals, but did not include others, such as those who teach and supervise radiologic work in medical schools and those working in research institutions and government departments. More recently, the work has been extended to all of these fields. Questionnaires have recently been sent out and applications received from thirty-two of these specialists who were not included in the first survey. There has not been time to give to all the later applications the consideration that is due them, which will explain the omission of some from the list contained in the accompanying pages.

Additions and revisions will be made from time to time; suggestions for changes will be received and consideration of new applications will go on continuously. Cooperation by the men in the specialty has been excellent and must continue in order that the work may be of optimum value.

PATHOLOGISTS AND CLINICAL PATHOLOGISTS

The list of clinical pathologists which accompanied the list of radiologists in the Radiologic Number for May 23, 1931, is not included in the present issue but is being revised for a later issue of *The Journal*. This will give the necessary time for a thorough revision of that list, including a classification of pathologists and clinical pathologists so as to form a more accurate and a more useful list. Also, the pathologists and clinical pathologists connected with medical colleges, research institutions and government departments will be included, as is being done in the case of the radiologists.

ESSENTIALS FOR ADMISSION TO LIST OF PHYSICIANS SPECIALIZING IN RADIOLOGY

Physicians Eligible

Consideration for admission to the list is open to all regular licensed physicians engaged in radiologic work in accordance with the essentials, whether connected with a hospital or conducting an independent laboratory.

1. Qualifications

(*a*) The candidate shall be a graduate of a medical school that is approved by the Council on Medical Education and Hospitals and shall be licensed to practise medicine in the State in which his department is located. He shall also have had special training, such as is approved by the Council, in radiology, roentgenology or radium therapy at an acceptable school—preceptorship, hospital or clinic, department of radiology, roentgenology or radium therapy—for a period of at least three years, or, in lieu of such training, shall have had a minimum of five years' experience in the exclusive practice of radiology, roentgenology or radium therapy. He must be a man of good standing in the medical profession, and particularly among those specializing in radiology. He shall either be on a full-time

basis or have definite hours of attendance at the department, such hours to be ample to insure the element of medical consultation in every examination or treatment.

(*b*) The department shall be under the direction of a physician radiologist, roentgenologist or radium therapist, as the circumstances may require. The director shall be responsible for all examinations and treatments. He shall be responsible for all professional assistants and for the efficient maintenance of the department.

Physicians employed by laboratories which are under lay control and direction will not be eligible for consideration for this listing.

(*c*) *Assistants.*—The director may have a corps of qualified medical and technical assistants responsible to him, and for whom he is responsible, to carry out accurately the various functions of the department.

2. *Definitions*

Radiology.—The branch of medicine which deals with the diagnostic and therapeutic application of radiant energy, including roentgen rays, radium, ultra-violet rays and other spectral radiation.

Department of Radiology.—A private laboratory or department of a hospital, clinic or other institution, organized and equipped for the diagnostic and therapeutic application of radiant energy, including roentgen rays, radium, ultra-violet rays and other spectral radiation.

Radiologist.—A qualified physician who also has obtained adequate special training and experience in general radiology.

Roentgenology.—The phase of radiology which deals with the diagnostic and therapeutic application of roentgen rays only.

Department of Roentgenology.—A private laboratory or department of a hospital, clinic or other institution organized and equipped for the diagnostic and therapeutic application of roentgen rays only. A department organized and equipped solely for the diagnostic or therapeutic application of roentgen rays shall be known as a department of diagnostic or therapeutic roentgenology, respectively.

Roentgenologist.—A qualified physician who has had adequate training and experience in the diagnostic and therapeutic application of roentgen rays.

Diagnostic Roentgenologist.—A roentgenologist who limits his practice to the diagnostic phase of roentgenology.

Therapeutic Roentgenologist.—A roentgenologist who limits his practice to the therapeutic phase of roentgenology.

Radium Specialist.—A physician who has had adequate training and experience in the therapeutic use of radium and who specializes in this work.

3. *Scope*

A department of radiology should be able to render all of the following services:

(*a*) Roentgenography, simple or stereoscopic, of any part of the body, with medical interpretation of the roentgenographic observations, and under satisfactory conditions for the protection of the patient and of the professional and technical personnel.

(*b*) Roentgenoscopy of any part of the body, in any position, with or without opaque media, with medical interpretation of the roentgenoscopic observations, and under satisfactory conditions for the protection of the patient and the professional and technical personnel.

(*c*) Roentgenotherapy of all benign and malignant diseases amenable to such treatment with roentgen rays generated at low, moderate or high voltage (long, medium or short wave length), as the conditions may require, and under satisfactory conditions for the protection of the patient and of the professional and technical personnel.

(*d*) Radium therapy of all benign and malignant diseases amenable to such treatment with an adequate quantity of radium element or emanation, and under satisfactory conditions for the protection of the patient and of the professional and technical personnel.

Ultra-violet therapy, general or local, with satisfactory air-cooled and water-cooled quartz mercury lamps or carbon arc lamps, with suitable quartz and other applicators for irradiation of cavities, sinuses or the superficial lesions under pressure, and under satisfactory

conditions for the protection of the patient and of the professional or technical personnel. This stipulation is not mandatory, but the Council recommends that every department of radiology be equipped for ultra-violet therapy or that the ultra-violet equipment of hospitals be placed in the department of radiology. Ultra-violet treatment by the department of physical therapy shall not be countenanced unless such department is under the control and supervision of a medical director who has specialized in radiology.

A department of roentgenology should be able to render the services specified under *a*, *b* and *c*.

A department of diagnostic roentgenology should be able to render the services specified under *a* and *b*.

A department of therapeutic roentgenology should be able to render the services specified under *c*.

A department of radium therapy should be able to render the services specified in *d*.

4. Housing

The housing should be adequate for the proper functioning of the department of radiology or roentgenology. Damp or ill ventilated quarters are unsuitable for such work.

5. Equipment

The equipment should be sufficient to carry out properly the technical procedures and activities of the department of radiology, roentgenology or radium therapy.

6. Protection

The arrangement of working rooms and conditions, and the construction of all apparatus shall be such as to provide adequate protection, both from electrical shock and from avoidable exposure to roentgen rays or radium, to patients, attendants, and other persons in or near the department. The requirements in this respect are based on the recommendations adopted by the International Congress of Radiology, held at Stockholm, Sweden, in July, 1928, and approved by the American Roentgen Ray Society and the Radiological Society of North America.

7. Records

Full records of all examinations and treatments made by the department, suitably indexed, are essential. Roentgenograms made in the department should have inerasible identification marks which will preclude error as to patients concerned. Roentgenograms may be lent to referring physicians but should be returned to the laboratory for filing and future reference. Suitable storage facilities should be provided where roentgenograms and other records will be both safe and readily available for reference. They shall be kept as long as there is the possibility of their being needed for the benefit of the patients or their physicians.

As roentgenography constitutes only a kind of medical examination, on which the roentgenologist's opinion of the patient's condition is partly or wholly based, and as the opinion of the specialist is the essential factor, the Council holds that the introduction of roentgenograms as evidence in medico-legal cases should be discouraged as immaterial and as tending to adulterate the process of justice. There is no more reason for the introduction of roentgenograms than for requiring a pathologist to bring to court his microscope and his sections of tissues.

8. Reports

The reports of a department of radiology, roentgenology or radium therapy shall be made through the director on stationery or blanks having the name of the director printed thereon. Under no circumstances shall roentgenologic diagnoses, interpretations, opinions, statements of prognosis, or therapeutic suggestions be offered by the non-medical personnel.

9. Library

The department of radiology, roentgenology, or radium therapy should be provided with, or have convenient access to, a library including current scientific books and journals on all the various subjects required in its work.

10. Ethics, Fees and Publicity

Radiology is a special type of medical practice, and the physician practising radiology is subject to the same rules of special training and conduct that govern his fellow specialists in the practice of medicine and surgery. The Principles of Medical Ethics of the American Medical Association shall apply in all cases. The fees charged for radiologic services shall be under the control of the director of the department. All systems of rebates, discounts, special group rates, etc., shall be considered unethical, except that, in cases in which the patient's economic status is the determining factor, the radiologist, like his fellow physician in medicine or surgery, may waive part or all of the fee.

The publicity of a department of radiology, roentgenology or radium therapy should be in professional good taste and limited to statements of fact as to name, address and telephone number; names and titles of the director and other active responsible personnel; field of work covered, office hours, directions for referring patients, and so forth. It should not contain misleading statements or claims of unusual superiority. It should not advocate medical fads nor lay undue stress on the importance of roentgenologic observations. On the letterheads or any other form of publicity, only the names of those rendering regular services to the department should appear as being connected with the department. Advertising matter should be directed only to physicians, either through bulletins or through recognized technical journals, and never to the non-professional public, as, for example, by announcements in popular journals and periodicals, circulars, pamphlets or telephone lists.

11. Admission to the Approved List

Only when the physician is the director or is affiliated with a department of radiology, roentgenology or radium therapy in which the personnel, space, equipment, management, finances and records are such as will insure honest, efficient and accurate work may he expect to be listed. Physicians desiring to be considered for the approved list should apply to the Council on Medical Education and Hospitals of the American Medical Association, 535 North Dearborn Street, Chicago.

PHYSICIANS SPECIALIZING IN RADIOLOGY—1,003

The list contains the names of only those who responded to the questionnaire, who have been found to comply with the "Essentials," and who were recommended by the advisers for their respective States. Those who are still under consideration, and others who may apply, will, when accepted, be added in subsequent issues of *The Journal.*

The type of service rendered is given opposite the name. "Radiology," under "Type of Service," always includes short wave therapy, also known as "deep therapy." The asterisk (*) on "roentgenology" indicates that short wave therapy is included.

Alabama

Name and Address	*Type of Service*
Anniston	
Levi, Irwin P., 931 Noble St.	Roentgenology
Birmingham	
Barfield-Carter, M., 2031 1st Ave., N.	Roentgenology
Edmonson, John H., 1928 1st Ave., N.	Roentgenology
Kesmodel, Karl F., Medical Arts Bldg.	Roentgenology
Meadows, James A., 1928 1st Ave., N.	Roentgenology
Dothan	
Ellis, John T., 200 E. Main St.	Roentgenology
Montgomery	
Boswell, F. P., 201 Montgomery St.	Radiology

Arizona

Phoenix	
Goss, H. L., 125 W. Monroe St.	Roentgenology
Watkins, W. W., 12 N. Central Ave.	Radiology

Arkansas

Forth Smith	
Brooksher, W. R., 602 Garrison Ave.	Radiology
Hot Springs	
Nims, Charles H., 236 Central Ave.	Radiology
Little Rock	
Rhinehart, B. A., 701 Main St.	Roentgenology
Rhinehart, D. A., 701 Main St.	Roentgenology
Zell, A. M., 2000 Main St.	Radiology
Monticello	
Wilson, J. S.	Radiology

California

Alameda	
Lum, William T., 1361 Park St.	Roentgenology*
Bakersfield	
Fox, L. H., 2025 18th St.	Roentgenology
Berkeley	
Heald, E. Schulze, 3000 Regent St.	Roentgenology
Van Nuys, R. G., 2490 Channing Way	Radiology
Fresno	
Broemser, Milton A., 2014 Tulare St.	Radiology
Milholland, W. G., Bank of America Bldg.	Roentgenology
Ruff, Frank R., Burnett Sanatorium	Radiology
Glendale	
Jones, L. L., 229 N. Central Ave.	Roentgenology*
Hollywood	
Sherman, B. H., 6777 Hollywood Blvd.	Roentgenology
Stewart, Charles W., 1680 N. Vine St.	Roentgenology
Warren, J. W., 1322 N. Vermont Ave.	Radiology
Livermore	
Beaudet, E. A., Veterans Administration Hospital	Diagnostic roent.
Long Beach	
Heylmun, M. H., 115 Pine Ave.	Diagnostic roent.
Mayfield, Claude, 115 Pine Ave.	Diagnostic roent.
Los Angeles	
Bailey, Cornelius O., 727 W. 7th St.	Radiology
Blaine, Edward S., 727 W. 7th St.	Roentgenology
Bonoff, Karl M., 1930 Wilshire Blvd.	Roentgenology

Name and Address	*Type of Service*
Carter, Ray A., 1100 Mission Rd.	Roentgenology
Costolow, William E., 1407 S. Hope St.	Roentgen therapy Radium therapy
Davis, Kenneth S., St. Vincent's Hospital	Roentgenology*
Goin, Lowell S., 1930 Wilshire Blvd.	Roentgenology
Karshner, Rolla G., 510 S. Lucas Ave.	Roentgenology
Kibby, Sydney V., 417 S. Hill St.	Roentgenology
Martin, A. T., 269 S. Mariposa St.	Radiology
McKee, Edward N., 2173 Colorado Blvd., Eagle Rock	Roentgenology
Pindell, Merl Lee, 678 S. Ferris Ave.	Diagnostic roent.
Snure, Henry, 1414 S. Hope St.	Radiology
Soiland, Albert, 1407 S. Hope St.	Roentgen therapy Radium therapy
Stafford, Owen R., 520 W. 7th St.	Roentgenology
Taylor, Raymond G., 1212 Shatto St.	Radiology
Witter, Calvin B., 511 S. Bonnie Brae St.	Roentgenology*
Mare Island	
Pinner, William Ellis, U. S. Naval Hospital.	Roentgenology
Oakland	
Bissell, F. S., 434 30th St.	Roentgenology
Bowen, Carl B., 1624 Franklin St.	Roentgenology
Jelte, S. A., 230 Grand Ave.	Radiology
Petch, Philip H., 428 17th St.	Roentgenology
Peters, Charles E., 400 29th St.	Roentgenology*
Sargent, William H., 1624 Franklin St.	Roentgenology*
Siefert, Alfred C., Samuel Merritt Hospital	Radiology
Palo Alto	
Powers, Robert A., Medico-Dental Bldg.	Roentgenology
Pasadena	
Parker, Carl H., 65 N. Madison Ave.	Roentgenology*
Pomona	
Swearingen, F. C., 586 N. Main St.	Radiology
Redlands	
Folkins, F. H., 47 E. Vine St.	Roentgenology
Riverside	
Thuresson, Paul F., 3770 12th St.	Diagnostic roent.
Sacramento	
Cook, Orrin S., 1127 11th St.	Roentgenology
Graham, Ralph S., Sutter Hospital	Roentgenology*
Zimmerman, Harold, 1027 10th St.	Radiology
San Bernardino	
Owen, C. C., 398 6th St.	Roentgenology*
San Diego	
Elliott, A. E., 1831 4th St.	Radiology
Kinney, L. C., 1831 4th St.	Radiology
Weiskotten, W. O., 233 A St.	Diagnostic roent.
San Francisco	
Bryan, Lloyd, 450 Sutter St.	Roentgenology*
Crow, Lloyd B., 1400 Fell St.	Roentgenology*
Donovan, Monica, 450 Sutter St.	Roentgenology Radium therapy
Fulmer, Charles C., St. Luke's Hospital	Roentgenology
Garland, Leo H., 450 Sutter St.	Roentgenology*
Hunsberger, H. S., 450 Sutter St.	Diagnostic roent.
Ingber, I. S., 490 Post St.	Radiology
Newell, Robert R., 2361 Clay St.	Radiology
O'Neill, John R., 2200 Hayes St.	Roentgenology
Rehfisch, John M., 450 Sutter St.	Roentgenology*
Rodenbaugh, F. H., 490 Post St.	Radiology
Ruggles, Howard E., 384 Post St.	Roentgenology
Stone, Robert S., University of Calif. Hosp.	Roentgenology
Williams, Francis, 870 Market St.	Radiology
San Jose	
Richards, Charles M., 241 E. Santa Clara St.	Roentgenology*
San Pedro	
Allen, Albert, 410 W. 6th St.	Diagnostic roent.
Santa Barbara	
Geyman, M. J., 1520 Chapala	Radiology
Ullmann, H. J., 1520 Chapala	Radiology
Ware, James G., 1513 State St.	Roentgenology*
Santa Monica	
Hopkirk, C. C., 710 Wilshire Blvd.	Diagnostic roent.
Stockton	
Sheldon, F. B., 242 N. Sutter St.	Radiology
Woodland	
Lawson, John D.	Radiology

Colorado

Colorado Springs	
Brown, L. G., 707 N. Cascade Ave.	Radiology
Denver	
Allen, K. D., 227 16th St.	Roentgenology*
Brandenburg, H. P., 227 16th St.	Radiology
Childs, S. B., 227 16th St.	Radiology
Conyers, Chester A., 209 16th St.	Radiology
Crosby, L. G., 227 16th St.	Radiology
Diemer, Frederick E., 1612 Tremont St.	Diagnostic roent.
Newcomer, Elizabeth, 209 16th St.	Roentgenology*
Newcomer, N. B., 1616 Tremont St.	Radiology
Schmidt, Ernst A., 4200 E. 9th Ave.	Radiology
Stephenson, F. B., 227 16th St.	Roentgenology
Wasson, W. W., 227 16th St.	Radiology
Withers, Sanford, 1612 Tremont St.	Roentgenology Radium therapy
Longmont	
Matlack, J. A.	Diagnostic roent.
Sterling	
Daniel, J. H.	Roentgenology
Woodmen	
Forney, F. A.	Diagnostic roent.

Connecticut

Bridgeport	
Groark, Owen J., 881 Lafayette St.	Diagnostic roent.
LaField, W. A., 144 Golden Hill St.	Radiology
Parmelee, B. M., 144 Golden Hill St.	Radiology
Hartford	
Hoffman, Charles C., 700 Main St.	Diagnostic roent.
Ogden, Ralph T., 179 Allyn St.	Radiology
Roberts, Douglas J., 179 Allyn St.	Radiology
Van Strander, W. H., 179 Church St.	Diagnostic roent.
Meriden	
Otis, Fessendon N., 165 W. Main St.	Roentgenology
Middletown	
Murphy, James, 101 Broad St.	Diagnostic roent.
New Britain	
Grant, Arthur S., 55 W. Main St.	Roentgenology
New Haven	
Bergman, A. P., 27 Elm St.	Diagnostic roent.
Goldman, George, 201 Park St.	Diagnostic roent.
Scott, Clifton R., 215 Whitney Ave.	Roentgenology
Wheatley, Louis F., 420 Temple St.	Radiology
Norwalk	
Perkins, Charles W., 520 West Ave.	Roentgenology*
Willimantic	
Kinney, Kenneth K., 29 North St.	Roentgenology

Delaware

Wilmington	
Allen, B. M., 909 Washington St.	Diagnostic roent.
Burns, Ira, 601 Delaware Ave.	Diagnostic roent.
McElfatrick, G. C., 1024 W. 8th St.	Diagnostic roent.

District of Columbia

Washington	
Caylor, C. C., 1029 Vermont Ave., N.W.	Diagnostic roent.
Christie, A. C., 1835 I St., N.W.	Radiology
Coe, Fred O., 1835 I St., N.W.	Radiology
Elward, Joseph F., 1800 I St., N.W.	Roentgenology
Groover, T. A., 1835 I St., N.W.	Radiology
Lattman, Isidore, 1835 I St., N.W.	Radiology
McPeak, Edgar M., 1835 I St., N.W.	Radiology
Merritt, E. A., 1835 I St., N.W.	Radiology
Moore, A. B., 1835 I St., N.W.	Radiology
Moore, Claude, Geo. Washington Univ. Hosp.	Roentgenology
Otell, L. S., 1835 I St., N.W.	Radiology
Sappington, E. F., 1103 16th St., N.W.	Roentgenology
Spalding, Otis B., U. S. Naval Hospital	Roentgenology*

Florida

Clearwater	
Brown, Harold O.	Diagnostic roent.
Fort Lauderdale	
Hendricks, E. M., Sweet Bldg.	Radiology
Jacksonville	
Cunningham, L. W., 117 W. Duval St.	Roentgenology*
McEuen, H. B., 1721 Challen Ave.	Roentgenology*
Shaw, W. McL., 117 W. Duval St.	Roentgenology*
Lakeland	
Weed, Walter A., Morrell Memorial Hosp.	Roentgenology Radium therapy
Miami	
Cleghorn, Charles D., 168 S.E. 1st Ave.	Roentgenology Radium therapy
Lucinian, Joseph H., 168 S.E. 1st Ave.	Roentgenology*
Raap, Gerard, 168 S.E. 1st Ave.	Diagnostic roent. Radium therapy
Miami Beach	
Payton, Frazier J.	Roentgenology Radium therapy
Ocala	
Moore, J. N.	Diagnostic roent.
Orlando	
Pines, John A., Orlando Clinic	Roentgenology*
St. Petersburg	
Feaster, O. O., 103 5th St., S.	Roentgenology Radium therapy
Herring, John A., 350 3d Ave. N.	Diagnostic roent.
Sanford	
Marshall, C. J., 212 E. 1st St.	Radiology
Tampa	
Allen, Bundy, 706 Franklin St.	Roentgenology*
Dickinson, J. C., 706 Franklin St.	Roentgenology*
West Palm Beach	
Herpel, Frederick K., Good Samaritan Hospital	Diagnostic roent.

Name and Address	Type of Service
Georgia	
Americus	
Pendergrass, R. C.	Roentgenology*
Atlanta	
Clark, James J., 478 Peachtree St., N.E.	Roentgenology
Hall, O. D., Georgia Baptist Hospital	Radium therapy
Lake, William F., 384 Peachtree St., N.E.	Roentgenology*
Landham, J. W., 139 Forrest Ave., N.E.	Roentgenology Radium therapy
Rayle, Albert A., Steiner Cancer Clinic	Roentgenology
Stewart, Calvin B., Steiner Cancer Clinic	Radium therapy
Augusta	
Holmes, L. P., 753 Broad St.	Roentgenology
Savannah	
Cole, William A., 20 E. Taylor St.	Roentgenology
Corson, Eugene R., 10 W. Jones St.	Roentgenology*
Drane, Robert, Liberty and Drayton Sts.	Roentgenology Radium therapy
McGee, H. H., 14 E. Taylor St.	Roentgenology
Idaho	
Boise	
Genoway, Charles V., 105 N. 8th St.	Roentgenology*
Lewiston	
Johnson, Paul W.	Roentgenology*
Illinois	
Batavia	
Mostrom, H. T.	Diagnostic roent. Radium therapy
Belvidere	
Alguire, Alden	Diagnostic roent.
Bloomington	
Cantrell, Thomas, 310 E. Jefferson St.	Radiology
Grote, Henry W., 219 N. Main St.	Radiology
Chicago	
Arens, Robert A., 2839 Ellis Ave.	Radiology
Beilin, David S., 411 Garfield Ave.	Radiology
Blackmarr, Frank H., 25 E. Wash. St.	Roentgen therapy Radium therapy
Brams, Julius, 180 N. Michigan Ave.	Roentgenology
Brown, William L., 55 E. Wash. St.	Radium therapy
Casellas, P. R., 1525 E. 53d St.	Roentgenology
Challenger, C. J., 3117 Logan Blvd.	Roentgenology
Cook, Carroll E., 30 N. Michigan Ave.	Radiology
Culpepper, William L., 1305 E. 63d St.	Roentgenology
Cushway, B. C., 7752 S. Halsted St.	Radiology
Cutrera, Peter, 501 N. Halsted St.	Diagnostic roent.
Damiani, Joseph, 767 Milwaukee Ave.	Roentgenology
Davis, H. E., 2548 Lake View Ave.	Diagnostic roent.
Dick, Paul G., 55 E. Washington St.	Roentgenology
Ford, Charles, 8017 Luella Ave.	Roentgenology
Gilmore, Wilbur H., 185 N. Wabash Ave.	Roentgenology
Grubbe, Emil H., 6 N. Michigan Ave.	Roentgen therapy
Hartung, Adolph, 25 E. Washington St.	Radiology
Hodges, Paul C., 928 E. 59th St.	Radiology
Hubeny, M. J., 25 E. Washington St.	Roentgenology
Jenkinson, David L., 1931 Wilson Ave.	Roentgenology*
Jenkinson, E. L., 1439 S. Michigan Ave.	Radiology
Kraft, Ernest, 950 E. 59th St.	Roentgenology*
Landau, George M., 660 Groveland Park	Roentgenology
Larkin, A. James, 25 E. Washington St.	Radium therapy
Litschgi, Joseph J., 551 Grant Pl.	Roentgenology
Maier, Roe J., 7752 S. Halsted St.	Radiology
McClure, C. F., 25 E. Washington St.	Roentgenology
Olin, Harry, 6058 Drexel Blvd.	Roentgenology
Orndoff, B. H., 2561 N. Clark St.	Roentgenology
Potter, Hollis E., 122 S. Michigan Ave.	Roentgenology
Rose, Cassie Belle, 1753 W. Congress St.	Radiology
Royer, Don J., 841 E. 63d St.	Roentgenology
Tichy, L. S., 3200 W. 22d St.	Roentgenology
Trostler, I. S., 25 E. Washington St.	Radiology
Wanninger, W. J., 9116 Exchange Ave.	Roentgenology
Warden, R. H., 1044 N. Francisco Ave.	Radiology
Warfield, C. H., Cook County Hospital	Roentgenology
Willy, R. G., 2749 W. Foster Ave.	Roentgenology
Danville	
Allison, Otis W., 9 W. Main St.	Radium therapy
Archibald, James S., 602 Green St.	Roentgenology
Dunham, L. H., 139 N. Vermilion St.	Radiology
Deerfield	
Davis, Charles J.	Roentgenology
East St. Louis	
Echternacht, A. C., 129 N. 8th St.	Radiology
Evanston	
Alexander, William G., 636 Church St.	Radiology
Conley, Bernard M., St. Francis Hospital	Roentgenology
Perry, Gentz, 636 Church St.	Radiology
Galesburg	
Gunning, R. E. Lee, 64 S. Prairie St.	Radiology
Highland Park	
Jacks, R. R., 16 N. Sheridan Rd.	Diagnostic roent.
Joliet	
Houston, Alfred M., 201 N. Chicago St.	Roentgenology
Mattoon	
Morgan, Charles E., 213 S. 17th St.	Roentgenology
Mount Carmel	
Elkins, Harold A.	Roentgenology
Mount Vernon	
Smith, Elmer M., 1001½ Broadway	Roentgenology
Oak Park	
Ronayne, Frank J., West Suburban Hospital	Radiology
Olney	
Weber, James A.	Diagnostic roent. Radium therapy
Ottawa	
Pettit, Roswell T., Illinois Valley Hospital	Diag. roent.
Peoria	
Goodwin, P. B., 530 N. Glen Oak Ave.	Radiology
Magee, H. B., 408 Main St.	Radiology
Quincy	
Beirne, H. P., 648 Hampshire St.	Radiology
Swanberg, Harold, 508 Maine St.	Radiology
Rockford	
Ackemann, H. W., 321 W. State St.	Radiology
Springfield	
O'Hara, F. S., 310½ S. 5th St.	Radiology
Indiana	
Crawfordsville	
Sigmond, H. W., 227 E. Main St.	Radiology
Evansville	
Cleveland, W. R., 22 N. W. 4th St.	Radiology
Meyer, Keith T., Protestant Deaconess Hosp.	Diagnostic roent.
Smith, William L., 412 S.E. 4th St.	Radiology
Fort Wayne	
Rodriguez, Juan, 2902 Fairfield Ave.	Radiology
Steele, M. F., 116 E. Berry St.	Diagnostic roent.
Truelove, A. O., 347 W. Berry St.	Radiology
Van Buskirk, E. M., 347 W. Berry St.	Radiology
Gary	
Dietrich, Paul H., St. Mary's Mercy Hosp.	Roentgenology
Indianapolis	
Beeler, R. C., 23 E. Ohio St.	Radiology
Collins, J. N., 23 E. Ohio St.	Radiology
Lochry, R. L., St. Vincent's Hospital	Roentgenology
Smith, L. A., 23 E. Ohio St.	Radiology
Stayton, Chester A., 23 E. Ohio St.	Roentgenology*
Kokomo	
Ferry, Paul W., 224 N. Main St.	Diagnostic roent.
LaFayette	
McClelland, D. C., 308 N. 8th St.	Roentgenology*
Michigan City	
Martin, F. V., 501 Pine St.	Radiology
Muncie	
Moore, P. D., Jackson and High Sts.	Radiology
New Castle	
Iterman, George E., 1319 Church St.	Roentgenology
Plymouth	
Knott, Harry	Roentgenology
Shelbyville	
Inlow, Herbert H., 2 W. Washington St.	Diagnostic roent.
Terre Haute	
Pierce, H. J., 627 Cherry St.	Radiology
Union City	
Reid, Robert W.	Roentgenology
Valparaiso	
DeWitt, C. H.	Diagnostic roent.
Vincennes	
Moore, Robert G., 21 N. 3d St.	Roentgenology
Iowa	
Anamosa	
Rawson, E. G.	Diagnostic roent.
Atlantic	
Greenleaf, W. S.	Roentgenology
Belle Plaine	
Newland, Don H.	Diagnostic roent.
Cedar Rapids	
Erskine, Arthur W., 120 3d Ave. S.E.	Radiology
Des Moines	
Burcham, Thomas A., 410 6th Ave.	Radiology
Dubuque	
Johnston, Wayne A., 1200 Main St.	Radiology
Eagle Grove	
Christensen, John R.	Roentgenology
Independence	
Shellito, J. C.	Roentgenology
Iowa City	
Gibbon, W. H., University Hospitals	Radiology
Kerr, H. Dabney, University Hospitals	Radiology
LeMars	
Larsen, W. W.	Roentgenology*
Marshalltown	
Talley, Louis F., Evangelical Deaconess Home and Hospital	Roentgenology
New Hampton	
Chandler, Orville B.	Diagnostic roent.

Name and Address	*Type of Service*
Ottumwa	
Herrick, John F., 103 S. Market St.	Radiology
Spilman, H. A., 103 S. Market St.	Diagnostic roent.

Kansas

Eldorado	
Dinsmore, W. S., 324 W. Central St.	Diagnostic roent.
Ellsworth	
Hissem, H. Z.	Diagnostic roent.
Eureka	
Moore, R. W.	Roentgenology
Fort Scott	
Prichard, J. R., 209 S. Main St.	Radiology
Kansas City	
Allen, Lewis G., 601 Minnesota Ave.	Radiology
Lawrence	
Jones, H. T., 107 E. 8th St.	Diagnostic roent.
Salina	
Brittain, O. R., 105 S. 7th St.	Roentgenology
Topeka	
Finney, Guy A., 901 Kansas Ave.	Roentgenology
Floersch, M. A., 700 Kansas Ave.	Roentgenology
Owen, Arthur K., 901 Kansas Ave.	Roentgenology
Wichita	
Frost, E. J., 227 E. Douglas Ave.	Radiology
Swope, Opie W., 105 N. Main St.	Radiology

Kentucky

Ashland	
Cooper, John Ralph, 1540 Winchester Ave.	Roentgenology*
Lexington	
Harding, Donnan B., 190 N. Upper St.	Radiology
Thompson, J. C., 207 N. Upper St.	Roentgenology
Louisville	
Bell, J. C., 332 W. Broadway	Radiology
Enfield, Charles D., 332 W. Broadway	Radiology
Fugate, I. T., 332 W. Broadway	Radiology
Herrmann, Henry C., 608 S. 4th St.	Radiology
Johnson, S. E., 101 W. Chestnut St.	Roentgenology
Keith, D. Y., 412 W. Chestnut St.	Radiology
Keith, J. P., 412 W. Chestnut St.	Radiology
Owensboro	
Gillim, P. D., 415 St. Ann St.	Roentgenology
Winchester	
Browne, I. H.	Diagnostic roent.

Louisiana

Alexandria	
Barker, H. O., 327 3d St.	Roentgenology
Baton Rouge	
Williams, Lester J., 221 3d St.	Radiology
Houma	
St. Martin, T. I.	Roentgenology
Mansfield	
Curtis, H. P. D.	Roentgenology
Monroe	
Moore, Daniel M., 128 De Siard St.	Roentgenology
New Orleans	
Bowie, E. R., 3503 Prytania St.	Radiology
Fortier, L. A., 2000 Tulane Ave.	Radiology
Gately, T. T., 2000 Tulane Ave.	Radiology
Granger, Amédée, 921 Canal St.	Roentgenology
Henderson, W. F., 3500 Prytania St.	Radiology
Menville, L. J., 921 Canal St.	Radiology
Samuel, E. C., 3503 Prytania St.	Radiology
Shreveport	
Barrow, S. C., 624 Travis St.	Radiology
Edwards, H. G. F., 624 Travis St.	Roentgenology
Harwell, W. R., 624 Travis St.	Radiology
Rutledge, C. P., 1030 Highland Ave.	Radiology
Thomas, A. Jerome, 624 Travis St.	Roentgenology

Maine

Auburn	
Cunningham, C. H., 66 Goff St.	Diagnostic roent.
Bangor	
Ames, Forrest B., 489 State St.	Roentgenology
Hunt, Barbara, 224 State St.	Radiology
Portland	
Cummings, Edson S., 12 Pine St.	Diagnostic roent.
Lamb, Frank W., 131 State St.	Diagnostic roent.
Thaxter, Langdon T., 2 Arsenal St.	Roentgenology
Waterville	
Goodrich, John P., 214 Main St.	Diagnostic roent.

Maryland

Baltimore	
Ashbury, Howard E., 101 Read St.	Roentgenology*
Baetjer, Frederick H., 4 E. Madison St.	Roentgenology
Burnam, Curtis F., 1418 Eutaw Pl.	Radiology
Evans, John, 101 Read St.	Roentgenology
Feldman, Maurice, 2425 Eutaw Pl.	Diagnostic roent.
Kahn, Max, 904 N. Charles St.	Roentgenology*
Ostro, Marcus, 1810 Eutaw Pl.	Roentgenology
Pierson, J. W., 1107 St. Paul St.	Roentgenology*
Sax, Benjamin J., 101 Read St.	Diagnostic roent.
Walton, Henry J., 104 W. Madison St.	Roentgenology
Waters, Charles A., 1100 N. Charles St.	Roentgenology
Wright, Harold E., 101 Read St.	Diagnostic roent.
Crisfield	
Collins, C. E.	Roentgenology
Cumberland	
Cowherd, F. G., 122 S. Centre St.	Roentgenology
Hagerstown	
Hoffmeier, F. N., Washington Co. Hosp.	Roentgenology

Massachusetts

Boston	
Blackett, Charles W., 35 Bay State Road	Roentgenology
Butler, P. F., 35 Bay State Road	Radiology
Coffin, W. K., 416 Marlboro St.	Roentgenology
Ellsworth, S. W., 520 Beacon St.	Roentgenology
George, Arial W., 43 Bay State Rd.	Roentgenology
Healy, Thomas R., 370 Marlboro St.	Roentgenology*
Holmes, George W., 265 Charles St.	Radiology
Leonard, Ralph D., 43 Bay State Rd.	Roentgenology
Liebman, Charles, 311 Commonwealth Ave.	Roentgenology
MacMillan, A. S., 483 Beacon St.	Roentgenology
Martin, William C., Mass. General Hosp.	Roentgenology
McCarthy, H. L., 479 Beacon St.	Roentgenology
O'Brien, Frederick W., 465 Beacon St.	Radiology
Osgood, Herman A., 144 Commonwealth Ave.	Roentgenology*
Ott, George J., 344 Commonwealth Ave.	Roentgenology
Perkins, Roy S., 520 Commonwealth Ave.	Roentgenology
Ritvo, Max, 485 Commonwealth Ave.	Radiology
Robins, Samuel A., 636 Beacon St.	Roentgenology
Sosman, M. C., Peter Bent Brigham Hosp.	Roentgenology*
Vance, R. G., 264 Beacon St.	Roentgenology
Vogt, E. C., 300 Longwood Ave.	Roentgenology
Watts, Henry F., 6 Monadnock St., Dor.	Diagnostic roent.
Wheatley, Frank E., 520 Beacon St.	Roentgenology
Whelan, Charles, 395 Commonwealth Ave.	Radiology
Brockton	
Packard, Loring B., 305 Prospect St.	Roentgenology
Chelsea	
Hutchinson, R. W., U. S. Naval Hospital	Roentgenology
Dalton	
Sullivan, P. J.	Roentgenology
Fall River	
Lindsey, John H., 151 Rock St.	Roentgenology
Tennis, M. N., 538 Prospect St.	Radiology
Fitchburg	
Jennings, Curtis H., 82 Mechanic St.	Roentgenology
Haverhill	
McFee, William D., 295 Mill St.	Roentgenology
Popoff, Constantine, 26 Summer St.	Roentgenology*
Sproull, John, 50 Merrimack St.	Radiology
Holyoke	
Harrington, Elmer J., 179 Chestnut St.	Roentgenology*
Lawrence	
Burgess, Charles J., 37 Whitman St.	Radiology
Lowell	
Mehan, Joseph A., 4 Park St.	Roentgenology
Stewart, Ralph C., 226 Central St.	Roentgenology
Malden	
Warren, Alva H., 6 Pleasant St.	Roentgenology
New Bedford	
Bonnar, James M., 90 Hillman St.	Roentgenology
North Adams	
Bunce, James W., 85 Main St.	Roentgenology
Crawford, J. W., 191 E. Main St.	Radiology
Northampton	
Janes, Benjamin F., 211 Elm St.	Roentgenology
Somerville	
Blake, Allen H., 81 College Ave., W. Som.	Roentgenology
Springfield	
Davis, Ernest L., 20 Maple St.	Roentgenology
Horrigan, A. J., 20 Maple St.	Roentgenology
Jackson, Howard L., 146 Chestnut St.	Roentgenology
Powers, Richard T., 25 Maple St.	Diagnostic roent.
Van Allen, Harvey W., 19 Maple St.	Radiology
Webster	
Bragg, Leslie R., 260 Main St.	Diagnostic roent.
Worcester	
Cook, Philip H., 27 Elm St.	Roentgenology Radium therapy
Langill, Morton H., 36 Pleasant St.	Roentgenology

Michigan

Adrian	
Chase, A. W., 130 Toledo St.	Diagnostic roent.
Ann Arbor	
Donaldson, Sam W., St. Joseph's Mercy Hospital	Roentgenology
Hodges, Fred J., University of Michigan	Roentgenology
Peirce, Carleton B., University Hospital	Radiology
Battle Creek	
Gorsline, C. S., Old Merchants Tower	Roentgenology
Kolvoord, Theodore, 65 W. Michigan St.	Roentgenology
Upson, W. O., Leila Y. Post Montgomery Hospital	Roentgenology

Name and Address	Type of Service
Bay City	
Moffatt, Francis J., Mercy Hospital	Roentgenology
Detroit	
Berris, J. M., 10 Peterboro St.	Diagnostic roent.
Birkelo, Carl C., 28 W. Adams Ave.	Roentgenology
Bloom, Arthur R., 5057 Woodward Ave.	Roentgenology
Chene, George C., 1551 Woodward Ave.	Roentgenology
Dempster, James H., 1551 Woodward Ave.	Diagnostic roent.
Doub, Howard P., Henry Ford Hospital	Radiology
Evans, William A., 10 Peterboro St.	Radiology
Hasley, Clyde K., 1551 Woodward Ave.	Radiology
Jarre, Hans A., 1551 Woodward Ave.	Radiology
Kenning, J. C., 28 W. Adams Ave.	Roentgenology
Lim, W. K., 2201 E. Jefferson Ave.	Radiology
Loucks, R. E., 337 W. Grand Blvd.	Radiology
Minor, Edward G., 3001 W. Grand Blvd.	Roentgenology
Reynolds, Lawrence, 10 Peterboro St.	Radiology
Sanderson, S. E., 5057 Woodward Ave.	Radiology
Shore, O. J., 3001 W. Grand Blvd.	Roentgenology
Stevens, Rollin H., 1551 Woodward Ave.	Radiology
Ulbrich, Henry L., 1122 E. Grand Blvd.	Roentgenology*
Weaver, Clarence E., 113 Martin Pl.	Roentgenology
Flint	
MacDuff, Robert B., Hurley Hospital	Roentgenology*
Grand Rapids	
Menees, Thomas O., Blodgett Memorial Hosp.	Radiology
Moore, Vernor M., 110 E. Fulton St.	Radiology
Muller, John H., 26 Sheldon Ave.	Radiology
Williams, Alden H., 26 Sheldon Ave.	Radiology
Jackson	
Cooley, R. M., Mercy Hospital	Roentgenology
Kugler, J. C., 1905 Grovedale Ave.	Roentgenology
Porter, H. W., 1020 E. Michigan Ave.	Radiology
Kalamazoo	
Crane, A. W., 420 S. Rose St.	Roentgenology*
Jackson, John B., 420 S. Rose St.	Roentgenology*
Lansing	
Davenport, Carroll S., St. Lawrence Hosp.	Roentgenology*
Monroe	
Moll, T. M., 120 Maple Blvd.	Diagnostic roent.
Pontiac	
Church, J. E., 35 W. Huron St.	Roentgenology
Pool, H. H., 35 W. Huron St.	Roentgenology
Saginaw	
Anderson, William K., 316 S. Porter St.	Diagnostic roent.
St. Johns	
Ho, T. Y.	Diagnostic roent.
Traverse City	
Minor, E. B., 208½ E. Front St.	Diagnostic roent.
Ypsilanti	
Pillsbury, Charles B., 23B N. Wash. St.	Diagnostic roent.

Minnesota

Duluth	
Clement, Gage, 901 E. 1st St.	Radiology
Mankato	
Wentworth, A. J., Mankato Clinic	Radiology
Minneapolis	
Allison, R. G., 74 S. 9th St.	Roentgenology*
Fleming, A. S., 900 Nicollet Ave.	Radium therapy
Harrington, Charles D., 78 S. 9th St.	Radiology
Nordin, G. T., 74 S. 9th St.	Roentgenology*
Rigler, Leo G., University Hospital	Diagnostic roent.
Sundt, Mathias, 2323 6th St. S.	Roentgenology
Ude, Walter H., 74 S. 9th St.	Roentgenology*
Rochester	
Bowing, Harry H., 102 2d Ave.	Roentgenology Radium therapy
Camp, John D., Mayo Clinic	Diagnostic roent.
Desjardins, A. U., Mayo Clinic	Roentgen therapy Radium therapy
Ford, Frances A., Mayo Clinic	Radium therapy
Fricke, Robert E., Mayo Clinic	Radium therapy
Kirklin, B. R., Mayo Clinic	Diagnostic roent.
Leddy, Eugene T., Mayo Clinic	Radium therapy
Sutherland, Charles G., Mayo Clinic	Diagnostic roent.
Weber, Harry M., Mayo Clinic	Diagnostic roent.
St. Cloud	
Kern, M. J., St. Mary's Bldg.	Roentgenology*
St. Paul	
Aurelius, J. R., 350 St. Peter St.	Roentgenology*
Schons, Edward, 350 St. Peter St.	Radiology

Mississippi

Gulfport	
Sims, George P., 1005 32d Ave.	Diagnostic roent.
Laurel	
McCormick, H. G., 531 7th St.	Roentgenology
McComb	
Ratcliff, M. D., Maryland and 4th Sts.	Diagnostic roent.
Natchez	
Beekman, Marcus, 307 Franklin St.	Diagnostic roent.

Missouri

Holden	
Thompson, William G.	Radiology
Joplin	
McCaughey, H. D., 607 Main St.	Radiology
Kansas City	
Dann, David S., 304 E. 12th St.	Roentgenology
DeWeese, E. R., 904 Grand Ave.	Roentgenology
Donaldson, C. O., 1103 Grand Ave.	Radiology
Lockwood, Ira H., 304 E. 12th St.	Radiology
McCandless, O. H., 308 E. 12th St.	Roentgenology
McDermott, J. L., 1103 Grand Ave.	Radiology
Skinner, Edward H., 1103 Grand Ave.	Radiology
Virden, C. E., 1103 Grand Ave.	Radiology
St. Joseph	
McGlothlan, A. B., 824 Edmond St.	Roentgenology*
Ravold, Henry J., 401 N. 6th St.	Roentgenology
St. Louis	
Ernst, Edwin C., 3720 Washington Ave.	Radiology
McCutchen, L. G., 508 N. Grand Blvd.	Roentgenology*
Moore, Sherwood, Barnes Hospital	Radiology
Mueller, Wilbur K., 607 N. Grand Blvd.	Roentgenology
Peden, Joseph C., 634 N. Grand Blvd.	Roentgenology
Sante, L. R., 634 N. Grand Blvd.	Radiology
Spinzig, Edgar W., 508 N. Grand Blvd.	Roentgenology
Titterington, P. F., 508 N. Grand Blvd.	Roentgenology
Zink, Oscar C., St. Luke's Hospital	Roentgenology
Springfield	
Cole, Paul F., 200 Pershing Ave.	Radiology
Webster Groves	
Kerrigan, Joseph A., 421 S. Elm St.	Diagnostic roent.

Montana

Billings	
Bridenbaugh, J. H., 208 N. Broadway	Radiology
Watkins, C. F., 115 N. 28th St.	Radiology
Great Falls	
Walker, Dora, 503 1st Ave. N.	Roentgenology

Nebraska

Beatrice	
Penner, H. G., 113 S. 5th St.	Roentgenology*
Rush, Weaver A., 112½ S. 6th St.	Radiology
Grand Island	
Woodruff, R. C., 306½ N. Locust St.	Roentgenology
Hastings	
Rork, Lee W., 119 N. Hastings Ave.	Roentgenology*
Lincoln	
Kail, Carl, 1307 N St.	Roentgenology*
Rowe, Edward W., 128 N. 13th St.	Radiology
Smith, Roscoe L., 1307 N St.	Radiology
Omaha	
Fouts, Roy W., 107 S. 17th St.	Radiology
Hardy, Clyde C., 101 S. 17th St.	Roentgenology
Hunt, Howard B., Nebraska Methodist Episcopal Hospital	Roentgenology
Kelly, J. F., 107 S. 17th St.	Radiology
Overgaard, A. P., 107 S. 17th St.	Roentgenology
Ross, W. L., 407 S. 16th St.	Roentgenology
Tyler, Albert F., 103 S. 17th St.	Radiology
Scottsbluff	
Plehn, Frank W.	Roentgenology

Nevada

Reno	
Piersall, C. E., 120 N. Virginia St.	Radiology

New Hampshire

Concord	
Eveleth, Fred S., 12 Court St.	Roentgenology
Dover	
Chesley, Harry O., 507 Central Ave.	Roentgenology
Hanover	
Sycamore, Leslie K., Mary Hitchcock Memorial Hospital	Radiology
Manchester	
Merrill, A. S., 944 Elm St.	Roentgenology
Nashua	
Davis, S. G., 168 Main St.	Roentgenology
Rock, T. F., 77 Main St.	Diagnostic roent.

New Jersey

Asbury Park	
Herrman, William G., 501 Grand Ave.	Radiology
Atlantic City	
Bradley, Robert A., 1616 Pacific Ave.	Radiology
Kaighn, Charles B., 905 Pacific Ave.	Roentgenology
Camden	
Roberts, Joseph E., 403 Cooper St.	Roentgenology
East Orange	
Marquis, W. James, Homeopathic Hospital of Essex County	Roentgenology
Reitter, George S., 144 Harrison St.	Diagnostic roent.
Elizabeth	
Vogel, Herbert A., 1060 E. Jersey St.	Diagnostic roent.
Ward, Leo J., 137 W. Jersey St.	Radiology
Englewood	
Edwards, James B., Englewood Hospital	Roentgenology

Name and Address	*Type of Service*
Flemington	
Tompkins, G. B.	Diagnostic roent.
Hoboken	
Broeser, Henry V., 105 Newark St.	Roentgenology
Jersey City	
Maver, William W., 532 Bergen Ave.	Roentgenology
Perlberg, Harry J., 921 Bergen Ave.	Roentgenology
Montclair	
Schimmelpfennig, R. D., 65 N. Fullerton Ave.	Roentgenology
Stevens J. Thompson, 55 Park St.	Radiology
Newark	
Baker, Charles F., 198 Clinton Ave.	Roentgenology*
Gelber, Louis J., 41 Lincoln Ave.	Roentgenology
Hood, Philip G., 19 Lincoln Park	Diagnostic roent.
May, Ernst A., 965 Broad St.	Radiology
Reissman, Erwin, 31 Lincoln Park	Diagnostic roent.
Passaic	
Terhune, Percy H., 171 Paulison Ave.	Roentgenology
Paterson	
Golding, Harry N., 180 Carroll St.	Roentgenology
Roemer, Jacob, 213 Broadway	Radiology
Rochelle Park	
Pallen, C. de S.	Radium therapy
Succasunna	
Plume, C. A.	Diagnostic roent.
Summit	
Tidaback, John D., 382 Springfield Ave.	Roentgenology
Trenton	
Davison, R. Winthrop, 200 E. State St.	Radiology

New Mexico

Albuquerque	
Warden, M. R., St. Joseph's Hospital	Diagnostic roent.

New York

Albany	
Howard, W. P., 46 Willett St.	Roentgenology
Prentice, D. D., 59 Clinton Ave.	Radiology
Amsterdam	
Wilson, David, 156 Guy Park Ave.	Roentgenology
Auburn	
Austin, Sedgwick E., 54 E. Genesee St.	Diagnostic roent.
Bull, Harry S., 10 South St.	Roentgenology
Binghamton	
Kann, Ulysses S., 69 Walnut St.	Radiology
Brooklyn	
Bayles, William H., 1901 Bedford Ave.	Diagnostic roent.
Bell, A. L. Loomis, 340 Henry St.	Radiology
Cramp, George W., Methodist Episcopal Hosp.	Diagnostic roent
Currin, Francis W., 1136 Dean St.	Radiology
Dannenberg, Max, 1464 Eastern Parkway	Roentgenology
Eastmond, Charles, 483 Washington Ave.	Roentgenology*
Ehrenpreis, B., 576 Eastern Parkway	Roentgenology
Elliott, F. E., 122 76th St.	Diagnostic roent.
Friedmann, Asa B., 41 Eastern Parkway	Radiology
Gold, Louis, 835 Willoughby Ave.	Diagnostic roent.
Goldfarb, L., 608 Ocean Ave.	Diagnostic roent.
Howes, William E., 152 Clinton St.	Roentgenology
Ingraham, Ruth, 121 DeKalb Ave.	Diagnostic roent.
Kaufman, Julius, 201 Eastern Parkway	Roentgenology
Levine, Isaac, 1219 49th St.	Diagnostic roent.
Liberson, F., 612 Eastern Parkway	Diagnostic roent.
Masterson, John J., 401 76th St.	Roentgenology
Rendich, Richard A., 116 Remsen St.	Roentgenology
Schenck, Samuel G., 1538 President St.	Diagnostic roent.
Schiff, Charles H., 1000 Park Pl.	Diagnostic roent.
Strahl, Milton I., 255 New York Ave.	Diagnostic roent.
Taormina, Louis J., 1093 Gates Ave.	Roentgenology
Teperson, H. I., 1488 Eastern Parkway	Radiology
Wasch, Milton G., 871 Park Pl.	Radiology
Buffalo	
Barnes, John M., Millard Fillmore Hosp.	Roentgenology
Bayliss, J. W., 472 Delaware Ave.	Diagnostic roent.
DeGraff, Ralph M., 131 Linwood Ave.	Diagnostic roent.
Gian-Franceschi, J. S., 610 Niagara St.	Diagnostic roent.
Helminiak, M. J., 929 Fillmore Ave.	Diagnostic roent.
Koenig, Edward C., 100 High St.	Diagnostic roent.
Lape, C. Pearley, 183 Oxford Ave.	Diagnostic roent.
Levy, Sidney H., 33 Allen St.	Diagnostic roent.
Levyn, Lester, 40 North St.	Roentgenology
Moses, Chester D., 563 Riley St.	Diagnostic roent.
Orr, Clifford R., 1093 Ellicott St.	Roentgenology*
Schreiner, B. F., 113 High St.	Radiology
Smith, B. B., 333 Linwood Ave.	Diagnostic roent.
Thompson, A. W., 135 Linwood Ave.	Diagnostic roent.
Cooperstown	
Cruttenden, Harry L.	Radiology
Cortland	
Sornberger, Frank F., 16 Church St.	Roentgenology
Elmira	
Bennett, John A., 222 W. Church St.	Roentgenology
Far Rockaway	
Rivkin, Hyman, 918 Cornaga Ave.	Diagnostic roent.
Glens Falls	
Birdsall, Edgar, 140 Glen St.	Roentgenology
Gloversville	
Denham, H. C., 12 Prospect Ave.	Roentgenology
Hempstead	
Robin, Nathaniel H., 131 Fulton Ave.	Roentgenology
Williams, P. A., 131 Fulton Ave.	Roentgenology*
Hornell	
Mitchell, George W., 208 Main St.	Roentgenology
Hudson	
Harris, Rosslyn P., 427 Warren St.	Diagnostic roent.
Lackawanna	
Cotter, Stephen V., 1457 Abbott Rd.	Roentgenology
Mechanicsville	
Green, George A.	Diagnostic roent.
Mount Kisco	
Vaughan, F. E.	Diagnostic roent.
Newburgh	
Miller, Raymond A., 212 Grand St.	Diagnostic roent.
Reed, Charles B., 205 Liberty St.	Roentgenology
New Rochelle	
Duckworth, Willard D., 421 Huguenot St.	Roentgenology
New York City	
Arons, Isidore, 30 E. 49th St.	Roentgen therapy Radium therapy
Bendick, Arthur J., 100 E. 94th St.	Radiology
Besser, Herman, 66 E. 56th St.	Roentgenology
Carty, John R., 27th St. and 1st Ave.	Roentgenology
Cole, Lewis Gregory, 36 E. 61st St.	Roentgenology*
Dieffenbach, W. H., 50 Central Park West	Radiology
Dixon, George S., 218 2d Ave.	Diagnostic roent.
Ferguson, A. B., 420 E. 59th St.	Roentgenology
Fineman, S., 40 E. 49th St.	Diagnostic roent.
Freid, Jacob R., 1049 Park Ave.	Radiology
Friedman, Lewis J., 315 E. 18th St.	Roentgenology
Glassman, I., 138 E. 36th St.	Diagnostic roent.
Golden, Ross, 622 W. 168th St.	Roentgenology
Gottlieb, Charles, 210 W. 79th St.	Roentgenology
Groeschel, L. B., 40 W. 72d St.	Radiology
Hirsch, Henry, 2075 Grand Concourse	Radiology
Hirsch, I. Seth, 136 E. 64th St.	Radiology
Howard, J. Campbell, 40 E. 61st St.	Roentgenology*
Imboden, Harry M., 30 W. 59th St.	Radiology
Jaches, Leopold, 100 E. 94th St.	Radiology
Kaplan, Ira I., 55 E. 86th St.	Roentgen therapy Radium therapy
Kaplan, Morris, 130 Henry St.	Diagnostic roent.
Katz, Harry, 141 Broome St.	Diagnostic roent.
Kurz, Bernard, 1235 Grand Concourse	Diagnostic roent.
Landsman, I. J., 391 E. 149th St.	Diagnostic roent.
Lapman, Charles, 2754 Grand Concourse	Diagnostic roent.
Law, Frederick M., 140 E. 54th St.	Diagnostic roent.
Lefrak, Louis, 251 E. Broadway	Diagnostic roent.
Lenz, Maurice, 1049 Park Ave.	Roentgen therapy Radium therapy
LeWald, L. T., 140 E. 54th St.	Roentgenology
Lewis, Raymond W., 30 E. 40th St.	Diagnostic roent.
Meyer, William Henry, 1 University Place	Roentgenology*
Philips, Herman B., 9 W. 68th St.	Radiology
Pomeranz, M. M., 911 Park Ave.	Radiology
Powell, C. B., 2368 7th Ave.	Diagnostic roent.
Quimby, Adoniram J., 5 E. 57th St.	Roentgenology
Remer, John, 200 W. 59th St.	Roentgen therapy
Robinson, G. Allen, 2 E. 77th St.	Radium therapy
Robinson, William T., 322 W. 72d St.	Roentgenology
Ryan, E. J., St. Luke's Hospital	Roentgenology
Scholz, Thomas, 38 E. 85th St.	Diagnostic roent.
Schwartz, C. W., 33 E. 68th St.	Roentgenology
Schwartz, Irving, 1150 5th Ave.	Diagnostic roent.
Spillman, Ramsay, 115 E. 61st St.	Diagnostic roent.
Steiner, Joseph M., 170 East End Ave.	Roentgenology*
Stewart, William H., 222 W. 79th St.	Roentgenology
Taylor, Henry K., 333 West End Ave.	Diagnostic roent.
Unger, Arthur S., 135 E. 74th St.	Roentgenology
Valenti-Mestre, A. F., 129 Broad St.	Roentgenology
Weinberg, Tobias B., 310 E. 15th St.	Roentgenology
Weitzner, Samuel F., 1018 E. 163d St.	Roentgenology
Niagara Falls	
Scott, Walter Roger, 598 Pine Ave.	Radiology
Ossining	
Wyser, Dorean D., Ossining Hospital	Roentgenology
Oswego	
Lavine, Reuben, 25 W. Oneida St.	Diagnostic roent.
Wallace, H. M., 140 W. 5th St.	Roentgenology
Peekskill	
Snowden, Fred A., 108 Depew St.	Roentgenology
Port Chester	
West, Theodore S., 324 Westchester Ave.	Radiology
Poughkeepsie	
Davison, Chester O., Vassar Brothers Hospital	Radiology
Richmond Hill	
Voltz, Albert L., 11520 Myrtle Ave.	Radiology
Rochester	
Almy, Max A., 16 N. Goodman St.	Roentgenology
Davidson, Sol C., 277 Alexander St.	Radiology
Flynn, James M., 277 Alexander St.	Radiology
Green, Joseph H., 277 Alexander St.	Roentgenology

Name and Address	*Type of Service*
Palmer, Myron B., 277 Alexander St.	Radiology
Sanders, L. J., 213 Alexander St.	Roentgenology
Thomas, Camp C., 476 Lake Ave.	Roentgenology
Saratoga Springs	
King, Earl H., 75 Caroline St.	Roentgenology
Syracuse	
Caliva, Salvatore, 510 Prospect Ave.	Diagnostic roent.
Childs, Donald S., 713 E. Genesee St.	Roentgenology
Henry, Lucas S., 116 E. Castle St.	Roentgenology
Potter, Carlton F., 820 S. Crouse Ave.	Roentgenology
Rulison, Foster C., 713 E. Genesee St.	Roentgenology
Troy	
Hull, Thurman A., 505 Broadway	Diagnostic roent.
Utica	
Powers, M. T., 250 Genesee St.	Roentgenology
Watertown	
Pawling, Jesse R., 100 Stone St.	Roentgenology Radium therapy
White Plains	
Duckworth, R. D., 57 Maple Ave.	Roentgenology
Sherman, Herbert, 99 Church St.	Roentgenology

North Carolina

Asheville	
Murphy, G. W., Flat Iron Bldg.	Roentgenology*
Charlotte	
Lafferty, Robert H., 127 W. 7th St.	Radiology
Phillips, Clyde C., 19 W. 7th St.	Radiology
Durham	
Reeves, R. J., Duke Hospital	Radiology
Greensboro	
Rhudy, Booker E., 101 N. Elm St.	Roentgenology
Raleigh	
Noble, Robert P., 131 W. Hargett St.	Roentgenology*
Statesville	
McElwee, R. S., Stearns Bldg.	Roentgenology
Winston-Salem	
Rousseau, J. P., 310 W. 4th St.	Radiology

North Dakota

Bismarck	
Berg, Henning Milton, 221 5th St.	Roentgenology*
Fargo	
Rothnem, Thomas Peter, 804 Broadway	Roentgenology
Grand Forks	
Woutat, H. G., 318 DeMers Ave.	Roentgenology
Minot	
Gates, Russell, 20 4th Ave. S.W.	Roentgenology*

Ohio

Akron	
Beals, John A., St. Thomas Hospital	Diagnostic roent.
Selby, John H., 159 S. Main St.	Roentgenology
Stall, A. H., City Hospital	Radiology
Stewart, J. E., 159 S. Main St.	Roentgenology
Ashtabula	
Collander, P. J., 217 Park Pl.	Roentgenology
Canton	
Peters, Chester M., 709 Cleveland Ave. N.W.	Radiology
Peterson, E. O., 120 Tuscarawas St. W.	Roentgenology*
Shorb, John E., 427 Market Ave. S.	Roentgenology*
Chillicothe	
Holmes, Ralph W., 57 W. Main St.	Roentgenology
Cincinnati	
Bader, E. R., 628 Elm St.	Radiology
Brodberger, William L., 2556 Eastern Ave.	Roentgenology
Brown, Samuel, 707 Race St.	Roentgenology*
Doughty, William M., 628 Elm St.	Radiology
Goosmann, Charles, 22 W. 7th St.	Radiology
Lange, Sidney, 19 Garfield Place	Radiology
Reineke, Harold G., Cincinnati Gen. Hosp.	Roentgenology*
Warne, B. M., 19 Garfield Place	Roentgenology
Cleveland	
Bettelheim, Frederick, 1020 Huron Rd.	Radiology
Farmer, H. L., 10515 Carnegie Ave.	Radiology
Freedman, Edward F., 25 Prospect Ave., N.W.	Roentgenology
Hill, W. C., 10515 Carnegie Ave.	Radiology
LeFevre, Walter I., 9400 Euclid Ave.	Roentgenology
Mahrer, H. A., 10515 Carnegie Ave.	Roentgenology
May, Raymond V., 10515 Carnegie Ave.	Radiology
May, Robert J., 10515 Carnegie Ave.	Radiology
McCoy, Charles C., Lakeside Hospital	Roentgenology*
McNamee, Edgar P., 25 Prospect Ave., N.W.	Diagnostic roent.
Nichols, B. H., 2050 E. 93d St.	Radiology
Osmond, John D., 10515 Carnegie Ave.	Radiology
Portmann, U. V., Cleveland Clinic	Roentgen therapy Radium therapy
Steel, David, Lakeside Hospital	Roentgenology
Thomas, M. A., 10515 Carnegie Ave.	Radiology
Columbus	
Bowen, Charles F., 332 E. State St.	Radiology
Means, Hugh J., 683 E. Broad St.	Radiology
Miller, W. H., 328 E. State St.	Radiology
Reinert, Edward G., 350 E. State St.	Radiology
Riebel, Frank A., 15 W. Goodale St.	Roentgenology
Weirauk, H. V., 9 Buttles Ave.	Roentgenology
Dayton	
Burnett, Harry W., 201 S. Main St.	Radiology
Delscamp, W. H., 201 S. Main St.	Roentgenology
Jones, Lynn M., 117 S. Main St.	Roentgenology*
Fremont	
Philo, D. W., 209 W. State St.	Roentgenology
Gallipolis	
Wilson, Milo	Radiology
Hamilton	
Benzing, George, R.D. 3	Radiology
Lakewood	
McDowell, John R., 15701 Detroit Ave.	Roentgenology
Shetter, North W., 14600 Detroit Ave.	Roentgenology
Lima	
Thomas, Herbert A., 131 N. Elizabeth St.	Radiology
Massillon	
Holston, J. D., Massillon City Hospital	Diagnostic roent.
Piqua	
Spencer, Robert D., 400 N. Main St.	Roentgenology
Salem	
Heck, Stanton, 1160 E. State St.	Roentgenology
Springfield	
Brubaker, E. R., 8 W. Main St.	Radiology
Steubenville	
Miller, J. E., 401 Market St.	Radiology
Toledo	
Kahn, Dalton, 237 Michigan St.	Roentgenology
Murphy, John T., 421 Michigan St.	Radiology
Warren	
Gauchat, Paul C., 197 W. Market St.	Roentgenology
Simpson, D. G., 1 Main St.	Roentgenology
Youngstown	
Bachman, M. H., 314 N. Phelps St.	Roentgenology*
Heberding, John, 151 W. Rayen Ave.	Roentgenology
Heeley, J. A., Youngstown Clinic	Roentgenology
Meyer, N. N., 23 Central Square	Diagnostic roent.
Zanesville	
Holston, J. G. F., 620 South St.	Roentgenology

Oklahoma

Enid	
Newell, W. B., 502 N. Independence St.	Roentgenology
Marlow	
Talley, C. N.	Diagnostic roent.
McAlester	
Johnston, James C., 216½ E. Choctaw Ave.	Roentgenology
Oklahoma City	
Heatley, John E., 119 N. Broadway	Diagnostic roent.
Myers, Ralph Emerson, 1200 N. Walker St.	Radiology
Roland, Marion M., 119 N. Broadway	Radiology
Shawnee	
Hughes, J. E., 14 E. 9th St.	Diagnostic roent. Radium therapy
Sulphur	
Annadown, P. V.	Diagnostic roent.
Tulsa	
Larrabee, W. S., 108 W. 6th St.	Roentgenology
Lhevine, Morris B., 108 W. 6th St.	Diagnostic roent.
Stuart, Leon H., 7 W. 6th St.	Roentgenology

Oregon

Portland	
Dixon, William, 193 11th St.	Diagnostic roent.
Haworth, Wallace, 193 11th St.	Roentgenology
Palmer, Dorwin L., 430 Morrison St.	Radiology
Walker, Ralph C., 364 Washington St.	Radiology
Wight, Otis B., 193 11th St.	Radium therapy

Pennsylvania

Allentown	
Smyth, Thomas L., 111 N. 8th St.	Radiology
Troxell, William C., 941 Hamilton St.	Radiology
Altoona	
Alleman, George E., 1410 12th Ave.	Roentgenology
Bliss, Gerald D., 1220 13th Ave.	Radiology
Ashland	
Mulligan, P. B.	Roentgenology
Bethlehem	
Leibert, H. F., 338 Wyandotte St.	Roentgenology
Chester	
Egbert, Walter E., 601 E. 13th St.	Roentgenology*
Sharpe, A. Maxwell, 708 Sproul St.	Roentgenology*
Clearfield	
Reiley, W. E.	Radiology
Coatesville	
Perkins, J. A., 367 Chestnut St.	Diagnostic roent.
Danville	
Hawley, S. J.	Roentgenology*
DuBois	
Gann, G. W., 49 E. Long Ave.	Roentgenology
McCormick, A. F., Maple Ave. Hospital	Roentgenology
Easton	
Quiney, James J., 309 Bushkill St.	Radiology

Name and Address	*Type of Service*
Erie	
Putts, B. Swayne, 117 W. 8th St.	Roentgenology
Greensburg	
McMurray, H. A., 107 S. Main St.	Roentgenology
Hanover	
Bortner, C. E., 123 York St.	Diagnostic roent.
Harrisburg	
Ritzman, A. Z., 234 State St.	Roentgenology
Hatboro	
Shoemaker, Robert, III	Roentgenology
Hazleton	
Dessen, Louis A., 4 W. Broad St.	Roentgenology
Huntingdon	
Keichline, John M.	Radiology
Johnstown	
Stewart, H. M., 406 Main St.	Radiology
Kingston	
Howell, G. L., Kingston Corners Bldg.	Roentgenology
Lancaster	
Davis, Henry B., 530 N. Lime St.	Roentgenology Radium therapy
Snoke, Paul O., 530 N. Lime St.	Roentgenology
Swab, Robert D., 23 E. Walnut St.	Roentgenology
Lebanon	
Boger, John D., 341 Cumberland St.	Diagnostic roent.
Lewistown	
Weaver, O. M., 12 S. Main St.	Roentgenology
Lock Haven	
Green, George D.	Roentgenology
McKeesport	
Snedden, A. R., 522 Walnut St.	Roentgenology
Meadville	
Gingold, Joseph R., Spencer Hospital	Roentgenology
New Castle	
Cooper, J. R., 111 E. North St.	Radiology
Norristown	
Campbell, Raymond F., 514 Swede St.	Diagnostic roent.
Perkasie	
Strouse, O. H.	Roentgenology
Philadelphia	
Barker, Walter C., Chestnut and 20th Sts.	Radiology
Bird, G. C., 1415 W. Erie St.	Roentgenology
Borzell, Francis F., 4940 Penn St.	Roentgenology
Bowen, David R., Pennsylvania Hospital	Radiology
Bromer, Ralph S., Hospital of the Protestant Episcopal Church	Roentgenology
Bruck, Samuel, 2104 Pine St.	Roentgenology
Carpenter, Samuel A., 2265 N. 16th St.	Roentgenology
Chamberlain, W. E., Temple Univ. Hosp.	Radiology
Clagett, A. H., 1737 Chestnut St.	Roentgenology
Cohen, Leon Solis, 1923 Spruce St.	Roentgenology
Downs, E. E., Jeannes Hospital	Radiology
Edeiken, Louis, 1923 Spruce St.	Radiology
Farrell, John T., Jr., 235 S. 15th St.	Roentgenology*
Gershon-Cohen, J., 1832 Spruce St.	Roentgenology
Henry, Robert W., 768 S. 15th St.	Roentgenology
Koenig, Carl F., 1734 Harrison St.	Roentgenology
Manges, Willis F., 235 S. 15th St.	Roentgenology*
Morgan, J. D., 2226 Delancey St.	Radiology
Newcomet, W. S., 3501 Baring St.	Radiology
Pancoast, Henry K., 3400 Spruce St.	Radiology
Pendergrass, Eugene P., 3400 Spruce St.	Radiology
Percival, M. F., Methodist Episcopal Hosp.	Radiology
Pfahler, George E., 1321 Spruce St.	Radiology
Post, Joseph W., 1930 Chestnut St.	Roentgenology
Rieger, Charles L. W., Hahnemann Medical College Hospital	Roentgenology*
Rosenbaum, George, 1521 Spruce St.	Radiology
Schmidt, William Henry, 1601 Walnut St.	Radiology
Sender, Arthur C., 1311 W. Allegheny Ave.	Roentgenology
Spackman, E. W., 1824 Chestnut St.	Roentgenology
Stull, H. Tuttle, 3300 N. Broad St.	Roentgenology
Vastine, Jacob H., 1321 Spruce St.	Radiology
Widmann, B. P., 250 S. 18th St.	Radiology
Wiley, Louis R., 1512 N. 15th St.	Roentgenology
Zulick, J. Donald, 2008 Walnut St.	Roentgenology
Philipsburg	
Benson, Andrew L.	Roentgenology
Pittsburgh	
Alley, Reuben G., Western Pennsylvania Hospital	Diagnostic roent.
Caldwell, C. S., 520 S. Aiken Ave.	Diagnostic roent.
Fisher, J. W., 500 Penn Ave.	Radiology
Gorfinkell, Julius, 3401 5th Ave.	Roentgenology
Grier, G. W., 500 Penn Ave.	Radiology
Grimm, Homer W., 500 Penn Ave.	Radiology
Johnston, Z. A., 500 Penn Ave.	Roentgenology
McAdams, Edward C., 119 S. Highland Ave.	Roentgenology
McCullough, John F., 500 Penn Ave.	Radiology
Ray, William B., 110 E. Stockton Ave.	Roentgenology*
Robinson, Ralph V., 500 Penn Ave.	Radiology
Schaefer, C. N., 500 Penn Ave.	Radiology
Schumacher, F. L., 500 Penn Ave.	Roentgenology
Reading	
Meter, Edward G., 230 N. 5th St.	Roentgenology*
Travis, Richard C., 249 N. 5th St.	Radiology
Rochester	
McCaskey, F. H.	Roentgenology
Scranton	
Jackson, B. H., 327 N. Washington Ave.	Radiology
Milkman, Louis A., 327 N. Washington Ave.	Roentgenology
von Poswik, Gisela, 217 Jefferson Ave.	Roentgenology
Shippensburg	
Stewart, Alexander	Roentgenology
Tamaqua	
Hinkel, William H., 243 E. Broad St.	Roentgenology
Uniontown	
Hess, George H., 104 Morgantown St.	Roentgenology
West Chester	
Pennell, Howard Y., Chester County Hosp.	Roentgenology
Wilkes-Barre	
DesJardins, A., Wilkes-Barre Gen. Hosp.	Roentgenology*
Rogers, Lewis L., 38 N. Franklin St.	Roentgenology
Wilkinsburg	
McGregor, William J., 901 Wood St.	Roentgenology
Williamsport	
Schneider, George L., 212 Pine St.	Roentgenology
Wursted, L. E., 416 Pine St.	Roentgenology
York	
Bennett, J. H., 1253 W. Market St.	Radiology
Landes, L. S., 454 W. Market St.	Diagnostic roent.
Lutz, J. Fletcher, 141 E. Market St.	Roentgenology

Rhode Island

Newport	
Wheatland, Marcus F., 84 John St.	Diagnostic roent.
Providence	
Albert, Simon, 108 Waterman St.	Diagnostic roent.
Batchelder, Philip, 188 Waterman St.	Roentgenology
Farrell, John T., 68 Jackson St.	Diagnostic roent.
Gerber, Isaac, 201 Waterman St.	Radiology
Kelley, Jacob S., 153 Smith St.	Diagnostic roent.
Woonsocket	
Garrison, Norman S., 38 Hamlet Ave.	Radiology

South Carolina

Anderson	
Wrenn, Frank, Anderson County Hospital	Radiology
Charleston	
Taft, Robert B., 105 Rutledge St.	Radiology
Columbia	
Pitts, Thomas A., 1515 Marion St.	Radiology
Rodgers, Floyd D., 1417 Hampton St.	Radiology
Florence	
Hay, Percy D., Jr., 111 W. Cheves St.	Radiology
Greenville	
Judy, W. S., 107 E. North St.	Roentgenology
Spartanburg	
Sheridan, William M., 116 W. Main St.	Radiology

South Dakota

Aberdeen	
McCarthy, Paul V.	Roentgenology
Pierre	
McLaurin, A. A.	Roentgenology*
Sioux Falls	
Nessa, Nelius J., 301 S. Minnesota Ave.	Roentgenology
Watertown	
Koren, F., Broadway and Kemp Ave.	Roentgenology*

Tennessee

Chattanooga	
Bogart, F. B., 546 McCallie Ave.	Roentgenology
Frere, John Marsh, 707 Walnut St.	Roentgenology*
Marchbanks, S. S., 546 McCallie Ave.	Radiology
Johnson City	
Hankins, John L., 300 N. Boone St.	Roentgenology
Peyton, R. L., Veterans Administr'n Home.	Roentgenology
Knoxville	
Abercrombie, Eugene, 603 W. Main Ave.	Roentgenology
Casenburg, S. F., 601 Walnut St.	Roentgenology
McCampbell, H. H., 614 Walnut St.	Radiology
Memphis	
Bethea, W. R., 869 Madison Ave.	Roentgenology*
Coley, Steve W., 1265 Union Ave.	Roentgenology*
Heacock, Charles H., 20 S. Dunlap St.	Radiology
Herring, J. H., 995 Madison Ave.	Roentgenology
King, J. Cash, 915 Madison Ave.	Roentgenology
Lawrence, W. S., 248 Madison Ave.	Radiology
Paine, Robert, 248 Madison Ave.	Radiology
Pulliam, H. N., 617 S. McLean Blvd.	Roentgenology
Robinson, W. W., 1291 Union Ave.	Roentgenology
Nashville	
McClure, C. C., 706 Church St.	Radiology
Shoulders, H. S., 706 Church St.	Roentgenology

Texas

Amarillo	
Van Sweringen, Walter, 301 Polk St.	Roentgenology
Vaughan, John H., 724 Polk St.	Radiology

Name and Address	*Type of Service*
Beaumont	
Ledbetter, L. H., 388 Pearl St.	Radiology
White, C. M., 595 Orleans St.	Roentgenology
Corsicana	
Curtis, Richard C., 101 N. Beaton St.	Roentgenology
Dallas	
Beaver, N. B., 1719 Pacific Ave.	Radiology
Martin, Charles L., 1719 Pacific Ave.	Radiology
Martin, J. M., 1719 Pacific Ave.	Radiology
Spangler, Davis, 4105 Live Oak St.	Radiology
Eastland	
Caton, J. H.	Roentgenology
El Paso	
Cathcart, J. W., 114 Mills St.	Radiology
Mason, C. H., 114 Mills St.	Radiology
York, M. N., Bassett Tower	Roentgenology
Fort Worth	
Bond, Tom B., 600 W. 10th St.	Radiology
Hyde, X. R., 600 W. 10th St.	Radiology
Jagoda, S., 1212 North St.	Radiology
O'Bannon, R. P., 1028 5th Ave.	Radiology
Houston	
Durrance, Fred Y., 1215 Walker Ave.	Diagnostic roent.
Harris, C. P., 1625 Main St.	Roentgenology*
McDeed, W. G., 1215 Walker Ave.	Roentgenology*
McHenry, R. K., 1215 Walker Ave.	Roentgenology
Sauermann, William O., 804 Travis St.	Roentgenology
Lubbock	
Smith, Jerome H., Lubbock Sanatorium and Clinic	Radium therapy
Mineral Wells	
Yeager, Robert L.	Roentgenology
Orange	
Barr, Richard E.	Radiology
San Antonio	
Barron, William Marshall, 705 E. Houston St.	Roentgenology*
Hamilton, W. S., 705 E. Houston St.	Diagnostic roent.
Lowry, R. H., Jr., Station Hospital, Fort Sam Houston	Roentgenology
Ostendorf, W. A., 507½ E. Houston St.	Roentgenology
Sherman	
Henschen, G. E., 500 N. Highland Ave.	Roentgenology*
Temple	
Giles, Roy G., Scott and White Clinic	Roentgenology*
Powell, Eugene V., 304 S. 22d St.	Radiology
Wilson, R. T., Scott and White Clinic	Roentgenology*
Waco	
Jenkins, I. Warner, 425 Austin Ave.	Radiology
Wichita Falls	
Wilcox, Clark A., 1300 8th St.	Roentgenology*

Utah

Salt Lake City	
Coray, Q. B., 54 E. South Temple St.	Roentgenology*
Kerby, James P., 9 Exchange Pl.	Roentgenology

Vermont

Burlington	
Caldwell, Nathan R., Mary Fletcher Hosp.	Roentgenology*
Robinson, Carl F., 266 Main St.	Roentgenology
Wilson, S. A., 150 Bank St.	Diagnostic roent.

Virginia

Lynchburg	
Spencer, Hunter B., Allied Arts Bldg.	Radiology
Newport News	
Davis, R. A., 2901 West Ave.	Roentgenology
Norfolk	
Eley, Clayton W., Hosp. of St. Vincent de Paul	Roentgenology*
Petersburg	
Clarkson, Wright, 30 Franklin St.	Radiology
Richmond	
Flanagan, E. L., 116 E. Franklin St.	Roentgenology
Gray, Alfred L., 118 E. Franklin St.	Roentgenology
Hodges, Fred M., 1000 W. Franklin St.	Radiology
Tabb, J. Lloyd, 1000 W. Grace St.	Roentgenology*
Talley, D. D., Jr., 501 E. Franklin St.	Roentgenology*
Whitehead, L. J., 501 E. Franklin St.	Roentgenology*
Roanoke	
Armentrout, John F., 30½ Franklin Rd.	Radiology
McKinney, Joseph T., 30½ Franklin Rd.	Roentgenology*
University	
Archer, Vincent W.	Roentgenology

Name and Address	*Type of Service*

Washington

Longview	
Hayes, Richard, 1267 Commerce Ave.	Roentgenology
Seattle	
Bourns, Frank S., 509 Olive St.	Radiology
Dwyer, Maurice F., 1115 Terry Ave.	Radiology
Garhart, Manch N., 1305 4th Ave.	Radiology
Holtz, Kenneth J., 920 2d Ave.	Roentgenology
Koenig, Carl E., 509 Olive St.	Roentgenology
Nichols, H. E., 1215 4th Ave.	Roentgenology
Snively, J. Howard, 509 Olive St.	Roentgenology*
Stephens, Lorenzo L., 1215 4th Ave.	Radiology
Thompson, H. B., 1305 4th Ave.	Radiology
Thomson, Curtis H., 1305 4th Ave.	Roentgenology*
Spokane	
Aspray, Joseph, 407 Riverside Ave.	Roentgenology
Betts, Arthur, 407 Riverside Ave.	Radiology
Ward, Charles B., 407 Riverside Ave.	Radiology
Tacoma	
Fishel, C. R., 740 St. Helens Ave.	Roentgenology
McCarty, E. D., 740 St. Helens Ave.	Roentgenology
Walla Walla	
Johannesson, C. J., 1 W. Main St.	Roentgenology
Yakima	
Cornett, George W., 321 E. Yakima Ave.	Roentgenology*

West Virginia

Charleston	
Lambert, A. C., 240 Capitol St.	Roentgenology
Fairmont	
Francis, Charles T., Cook Hospital	Roentgenology
Hollidays-Cove	
Davis, George H.	Diagnostic roent.
Huntington	
MacKenzie, A. R., 955 4th Ave.	Roentgenology*
Vinson, L. T., 317 9th St.	Roentgenology
Parkersburg	
Boice, Ralph Homer, 717 Ann St.	Roentgenology
Rose, Lonzo O., 510½ Market St.	Radiology
Wheeling	
Bippus, E. S., 77 16th St.	Roentgenology
Clovis, C. H., Ohio Valley General Hosp.	Radiology
Kalbfleisch, W. K., 58 16th St.	Roentgenology
Quimby, Will A., 1401 Market St.	Radiology

Wisconsin

Appleton	
McGrath, E. F., 114 W. College Ave.	Radiology
Beloit	
Wilson, Russell F., Beloit Municipal Hospital	Radiology
Eau Claire	
Baird, J. C., 401 S. Barstow St.	Roentgenology
Green Bay	
Olmsted, Austin O., 205 E. Walnut St.	Radiology
Shewalter, G. M., 305 E. Walnut St.	Roentgenology
Troup, R. L., 306 Cherry St.	Roentgenology
Janesville	
Kuegle, F. H., 19 S. Main St.	Roentgenology
Kenosha	
Bowing, Irwin E., 625 57th St.	Roentgenology
Sokow, Theodore, 723 58th St.	Radiology
LaCrosse	
McLoone, J. E., 319 Main St.	Roentgenology
Madison	
Littig, Lawrence V., 925 Mound St.	Roentgenology
Pohle, E. A., 1300 University Ave.	Radiology
Sisk, J. Newton, 16 S. Henry St.	Roentgenology Radium therapy
Marshfield	
Potter, R. P.	Roentgenology
Milwaukee	
Altenhofen, A. R., 152 W. Wisconsin Ave.	Roentgenology
Baumgarten, S., 205 E. Wisconsin Ave.	Roentgenology
Epperson, Paul S., 324 E. Wisconsin Ave.	Roentgenology
Habbe, John Edwin, 231 W. Wisconsin Ave.	Roentgenology
Podlasky, Harry B., 536 W. Wisconsin Ave.	Roentgenology
Zmyslony, W. P., 931 W. Mitchell St.	Diagnostic roent.
Neenah	
Greenwood, S. D.	Radiology
Salem	
Fletcher, William	Roentgenology
Superior	
Saunders, George, 1501 Tower Ave.	Roentgenology
Waukesha	
Peterson, George E., 831 N. Grand Ave.	Roentgenology

THE MANAGEMENT OF RADIOLOGIC PRACTICE IN HOSPITALS[1]

By D. S. BEILIN, M.D., Radiologist, Augustana Hospital, CHICAGO, ILLINOIS

THE management of radiologic practice in hospitals is a very timely subject. This paper is not intended for those who are seasoned in hospital radiologic practice—I am sure there are many of you who are more competent to present this subject than I. However, I have been interested in this subject for some time, and the present paper is the result of observations and investigations, which have been made during the past five years. The ideas and facts presented have been effectively carried out in general hospital radiologic practice, during the same length of time. It is understood that no fast rules and regulations can be made, as many institutions have their individual problems. The size of the hospital, and the character of the practice, whether private or charity, as well as numerous other obvious factors, bear a definite relationship to the management of radiologic practice. In a relative, practical way the following aspects are of importance.

The department of radiology in a hospital is an integral part of the institution: it plays a rôle closely associated with the other departments. Harmony and compatibility in their interrelationships are of considerable importance in maintaining efficiency.

Personnel.—The director of the radiologic department must be a graduate physician, licensed to practise; ethical; in good professional standing; with sufficient clinical experience and, in addition, special training in radiology. If the volume of work is adequate, it is preferable that the director of the department be a full-time man. Small hospitals, not able to afford a full-time radiologist, should be encouraged to share the part-time services of such a person. The small community with but one hospital will find it quite feasible for members of the hospital staff to pool their interests, and to select one of their number to make a special study of the subject, with a view toward directing the radiologic department. The radiologist should respond willingly to a call to the operating room, or to the bedside for consultation when necessary, for frequently he can be of considerable assistance. At all times the utmost co-operation between the radiologist and the medical staff should be maintained. The radiologist should be present at all clinical conferences, as well as at staff meetings. These views are in accord with those presented by the American College of Surgeons in the Manual of Hospital Standardization, and Hospital Standardization Report, for the year 1930. It is true that the radiologist has a referred practice, and should be considered as a consultant, but may I emphasize that if he expects to be considered as a consultant, he must so manage his department as to fulfill that status.

Radiologist's Compensation.—There is no strict uniformity in hospital practice in the manner of compensation for the services of the radiologist. We are all familiar with the various plans in practice. It is my opinion that the percentage basis of compensation for the services of the radiologist is productive of the best ultimate results to the hospital, its staff, its patients, and to the radiologist himself. The percentage basis gives the deserved reward for the maximum effort. Experience has taught that it is best to base the return on gross, rather than on net, income, chiefly because it obviates complicated bookkeeping and avoids misunderstandings, as well as resulting in happier attitudes. The percentage that the radiologist receives should be directly dependent upon

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the size of the institution, and the amount of work done; for instance, if a radiologist is in a small institution he should receive a larger percentage of the gross income. It should be borne in mind that, as a rule, the amount of work done is usually directly proportional to the ability of the radiologist in the department.

It is unfortunate that many physicians are insufficiently and inadequately taught on the subject of radiology in medical schools. It would appear that their chief enlightenment as to the real clinical importance and value of radiology commences with their hospital experience, and, therefore, it is usually a departmental program of education, instead of one which should have been given years before in the medical schools. This phase of the question is of the utmost importance, as, not infrequently, the secret to success of a radiologic department in a hospital is directly dependent upon the enlightenment of the attending men in the institution. I feel fairly safe in saying that the physicians obtaining value received in clinical information from their radiologist will insist that their patients have the necessary radiologic work.

Resident in Radiology.—In an institution of two hundreds beds or more, it is advantageous, as well as advisable, to have a resident in radiology. The resident should be a qualified physician who has an accredited interneship, and, if possible, some clinical experience, and particularly one who is desirous of specializing in radiology. The resident should have specific duties as well as regular services, and should be in charge of the department during the absence of its director. The hospital should provide full maintenance. The duties and services of the resident should embrace all branches of diagnostic work and as much therapeutic as the equipment of the hospital permits, so that on the completion of his service he shall be well qualified to set out in the field, either as an assistant in a large hospital or as a radiologist in a small organization. It would be well if the small community hospital which cannot afford the services of a seasoned radiologist would engage a resident in radiology on the completion of his services. This would enable the smaller institutions to have a better qualified service, as well as affording the beginner in radiology an opportunity for further experience and knowledge.

X-ray Technicians and Assistants.—It is important and preferable that X-ray technicians be somewhat familiar with clinical medicine as well as with nursing care. This type of work is particularly suitable for graduate nurses. This statement, however, does not imply that only graduate nurses are capable of doing this particular type of work. It is always an advantage to a radiologist to select certain nurses in his institution, and to train them in the technical and routine aspects of radiology. The training of X-ray technicians is a very important subject, as well as a controversial one. It is the experience of many that an intelligent nurse who is properly trained, usually makes, in approximately one year, an excellent radiographer, as well as an assistant in the department. The radiologist's secretary should be carefully selected and properly trained, in order to avoid errors which may result in serious circumstances.

Rules and Regulations Governing the Radiologic Department.—It is of paramount importance that rules and regulations governing the radiologic department be specifically stated and typewritten, and sent to the superintendent of the hospital, the superintendent of nurses, the attending physicians, internes, and supervisors of nurses on every floor, and be made available for the guidance of special and general nurses on duty. I know of no other practice which simplifies the management of radiology more effectively than this one. It is time that there should be some sort of consistency in these rules and regulations in hospital departments. A study of this phase of radiology by a special committee may result in a uni-

form concept which may be generally applied.

In the rules and regulations it should be definitely stated that the radiologist has entirely a referred practice. Each examination is considered a consultation, and the patient's charge is for the roentgen diagnosis, or a radiologic treatment. All reports and diagnoses are sent to the attending physician who has referred the case to the department. The patient will receive all information from his physician, thus maintaining the highest standard of medical ethics. The following rules and regulations for the radiologic department have been carried out efficiently during the past five years in the hospital of which I have most intimate knowledge.

Requisitions.—Every patient who is to have an X-ray examination is required to have a requisition made out for the examination in question by the attending physician, or by the interne on his service. Occasionally, requests are made orally to the supervisors on the floors, the attending physician being responsible for such orders. Requisitions must be completely filled out as to the following points: The patient's name, address, hospital admission number, clinical diagnosis, and the X-ray examination desired, stated specifically. All requisitions must be brought to the X-ray department before an examination can be made. The patient's hospital record must be brought to the X-ray department with him. The patient's name, address, name of attending physician, hospital case number, room number, X-ray admission number, the specific type of examination requested, and the charge for the examination, are all entered in the record book of the department. The patients are examined and instructed in detail regarding their orders. Requisition slips made out on Sundays, holidays, or outside of the regular hours of the department, for examinations, should be placed either in the X-ray department or left with the clerk in the admission office. The clerk in the admission office either sends the X-ray requisition to the department in the morning, or notifies the resident in the department or one of the technicians on call. The former, who resides in the hospital, may be consulted whenever necessary.

Hours of Service.—In any consultation practice the consultant is on call at any time. However, in radiologic practice in hospitals it is customary that the department be open when service is usually desired. Such hours are customarily from 8 A. M. to 5 P. M., with the exception of Sundays and holidays. It is not essential that the radiologist be available during the entire day, as the routine work is carried on by the assistants in the department. However, the services of many full-time radiologists are available from 9 A. M. to 5 P. M. Examinations desired outside of the regular hours may also be had by appointment.

Emergencies.—The urgency of the patient's symptoms alone constitutes an emergency. Emergencies will be given preference over regular routine work. Emergencies outside of the regular hours will be taken care of either by the resident or by one of the technicians on call. If necessary, communication should be had with the director of the department.

Ownership of Roentgenograms.—The question of the title in roentgenograms, so far as I have been able to ascertain, has not been decided upon by the Appellate or Supreme Court of Illinois. There are innumerable decisions on the use of films but the ownership is a question that, as far as I can find, has not reached the higher courts. It is basically a matter of contract, and comes under the same conditions as cover photographs and negatives. The law in the case of photographs is more or less settled, and there seems to be no question but that, in the absence of contract existing between the photographer and the subject, or the one engaging his services, the prints and nega-

tives belong to the subject. Of course, there is a custom of the photographers to retain negatives on orders for prints, but this custom has never given them title to the negatives, and, even if they have title, it is merely to the physical thing and not for its use for any purpose not permitted by the subject. In the matter of roentgenograms, the same law should logically apply. The fact that the roentgenograms are pictures of parts of the body seems to bring them within the category of photographs. The mere fact that they are taken in hospitals to determine a diagnosis should not change the relationship between the patient and the radiologist. It is, however, feasible and practical for the hospital to so arrange its routine with the patient as to have undisputed claim to the physical plates, or even to their promiscuous use. This can be done by a simple agreement on the face of the requisition for the X-ray work desired, signed by the patient at the time the roentgenograms are taken. In substance it can be stated as follows:

"All services rendered and billed for by the radiologic department shall be for roentgenologic diagnosis or for radiologic treatments, it being understood that the hospital retains title and ownership for all purposes to the physical plates developed."

This, however, is not very practical, although in certain instances it is preferable. It may be more to the point to have printed on the requisition slip, as well as on the bill and receipt submitted to the patient, the following:

"All services rendered and charges submitted by the radiologic department shall be for the roentgenologic diagnosis, it being understood that the hospital retains title and ownership for all purposes of the physical roentgenograms developed."

The mere posting of a notice to such effect in the radiologic department might also be effective if specifically called to the attention of the patient at the time.

Use of Plates.—The law is fairly well settled that, regardless of contract or conditions, a patient has a right to subpena from the institution all records necessary in any litigation that he may have as a result of injury sustained, in instances in which the records are pertinent to the issue in litigation. He can invoke this right by a subpena *duces tecum*. The courts have held that, even in cases in which the hospital bill is not paid, the patient can avail himself of this right.

Removing Films from the Hospital.—It should be specifically understood that the patients pay for the roentgen diagnosis. The films are the property of the institution, and a part of the permanent record. Films may be removed from the hospital temporarily or permanently with the permission of the attending physician. If the attending physician does not wish to have the films removed, the patient may have prints made from the films at a nominal cost. When films are removed from the hospital, copies of them are placed in a "preserver" which is marked on the outside "property of the hospital," and the original "preserver" is kept on file.

Individuals, other than the attending physician and patient, desiring to remove films from the hospital, or to obtain reports: Attorneys, insurance adjustors, and other physicians, desiring to remove films from the hospital, or desiring to see roentgen reports of cases in question, may do so only with the permission of the attending physician on the case.

Removing Films from the X-ray Department.—Upon application to the secretary in the office in the X-ray department, films may be taken after they have been interpreted. Occasionally, films may be removed before interpretation, such films being returned as promptly as possible. Films needed in the operating room or in other departments may be sent for or delivered, but must be returned immediately after their use.

Old Films.—Requests for old films (that is, for films more than four months old) should be made one day in advance if possible. When a large number of films is desired for study, lantern slides, etc., a notice of several days should be given. It is important that the rule for the removal of films from the hospital be adhered to.

Roentgen Reports.—Reports of examinations are sent to the attending physician on the same day, if the work is completed and if time permits; otherwise, the report is sent the following day. Reports of examinations requiring several days are sent immediately upon completion of the work. In all house cases a report is sent to the attending physician, one is placed on the patient's chart, and a copy is filed in the X-ray department. The attending physician may also receive a report of a case over the telephone. It is always preferable that reports be sent when the examination is completed.

Examination of Films by the Attending Physicians.—Films may be seen preferably in the X-ray viewing room in the afternoon; however, if necessary, they may be seen at any time during the regular hours of the department. If films are desired outside of regular hours, an appointment should be made with one of the personnel of the department. Physicians may consult the radiologist at any time; however, the afternoon is preferable.

Unsatisfactory Films.—Films which are technically unsatisfactory will be retaken, and a request to have the patient return will be noted on the report. In such cases a requisition marked "retake" should be sent. The patient will then be called to the X-ray department in the usual manner.

Photographs, Lantern Slides, Prints, etc.—These are made by a competent photographer, requisitions for such work being properly filled out, stating specifically what is desired, etc. Unless otherwise stated the bill for such work will be rendered to the physician requesting it.

Attending Physicians, Internes, Nurses, and Employees, Desiring Radiologic Work.—Such are examined without charge. Internes, nurses, and employees are required to have a requisition filled out for the examination in question by one of the attending physicians. Outside physicians desiring personal radiologic work are given a discount of 50 per cent.

Management of Radiologic Examinations.—Complete instructions for the management of all roentgenologic procedures are given in the rules and regulations governing the radiologic department. It is a general rule that the orders for all roentgenologic examinations are received from the roentgenologic department. For example, in all examinations of the gastro-intestinal tract the previous orders are automatically suspended, and the regular roentgenologic instructions for said examination are adhered to.

Identification of Roentgenograms in Court.—As a general rule of law roentgenograms can be identified only by the person who took and developed them. In some jurisdictions this is not as strictly held to as in others, permitting, at times, the head of the department, who is thoroughly familiar with the routine, to testify. However, in any event, the plates are not admissible as evidence unless properly identified, proper identification meaning the qualifying of the technician as an expert in his or her profession. On this point I am also advised that, once a subpena is issued from any court of record, having jurisdiction over the technician, to appear in court with the roentgenograms, and he does not appear, he is, of course, subject to contempt proceedings. However, courts as a rule are disposed to be considerate of the technician, knowing that the nature of his profession is such that he cannot always appear when called. If it is very inconvenient or impossible for the technician to testify at the certain time set forth by the court, he may often arrange, in ad-

vance, a suitable time for the taking of testimony.

Expert Testimony.—The average physician finds himself at a great disadvantage when he is called upon to appear in court as an expert witness. There are excellent articles on the medical expert witness, so I shall touch on only a few important aspects. Frequently, in cross-examinations, attorneys seek to embarrass physicians by putting questions framed in such a way that the answers, if given as requested, would be only partial statements of the facts, disconcerting to both the doctor and the side for which he is testifying. The best way to meet this situation is to appeal frankly to the court upon the theory that the question, as stated, or framed, cannot be answered fairly. If the court rules in favor of the cross-examining attorney, the doctor is compelled to answer. However, as a rule the court allows a good deal of latitude to save a physician in such a situation.

This does not apply in cases in which the cross-examining attorney is asking a question for the purpose of impeachment. The mere fact that a physician does not want to answer a question is no excuse. As sometimes happens, he has given testimony on direct examination, and under cross-examination reverses himself. The thing to keep in mind is that every cross-examining attorney seeks to do one thing with the physician who is not testifying for his side—to discredit his testimony as an expert. Often when roentgenograms are put in evidence the meaning of a certain mark, line, or density upon the roentgenogram comes into issue and it is not unusual for one group of physicians to interpret the line, mark, or density as significant, while the other side attaches no meaning to them whatsoever, or construes them as normal findings. This is solely a matter of opinion. The jury usually leans towards the decision of the doctors making the best impression. This impression is gathered both from the demeanor of the physician on the stand and his experience in his given field, as brought out by the evidence. Sadly enough, the weight of such testimony has very little to do with the actual facts.

In conclusion, may I state that I appreciate the diversity of viewpoints on the subject of the management of radiologic practice in hospitals, and have presented those aspects which have been proved by practice during the past five years.

DISCUSSION

DR. JAMES T. CASE (Chicago, Ill.): It seems to me that Dr. Beilin has admirably stated a manual of practice for the hospital in which he is engaged. Unfortunately the circumstances attending his practice are not duplicated in all hospitals. Evidently as the outgrowth of a good deal of thinking and collaboration with the physicians of the staff, he has been able to bring about a rather satisfactory manual of practice such as that which he has presented.

First of all, we must satisfy the attending staff. They have a right to be satisfied, and if what they want is not reasonable, we cannot simply deny it; instead, we must endeavor to persuade them that there is a better way. According to the years of our personal experience and our relation to the staff, we will have more or less success in getting them to see things as we want them to be seen.

As for requisitions for roentgen work, I think the problems should always be stated. I have recently hit upon a very effective, and yet simple, means of getting the staff members to state the problem they wish studied roentgenologically. I became tired of having men send in patients for "gastro-intestinal examination." or "colon," or "sinuses," or some other vague request. Therefore, I kept asking the superintendent to send out instructions that the attending men should give us the problem for the solution of which they send patients to the radiologic department. I long ago ceased to ask for a tentative diagnosis, because the average man is afraid to put it

down in writing. I ask for the *problem.* You do not send a boy into the basement to take a look at the basement. You send him down to see if a window is open, if the fire is burning in the furnace, if a prowler is there. You give him some reason for going.

So I adopted the practice of writing down the problem in my report. For instance, "The patient has an afternoon temperature, cough, etc.," if it is a question of lung examination, or I note if the patient has hemorrhage, or certain symptoms after meals, and so forth. You would be surprised to see how, since I have adopted the scheme of stating the problem, the staff has really gone to a great deal of pains to write out a statement of the problem in the language they would like to see in typewritten reports. When no problem has been stated, I take pains to say, "The requisition failed to state the problem." It has been very helpful. I do not know why I did not think of it long ago.

I note the question of the practice of roentgenology in hospitals has been brought up. It is an economic problem about which we should do a great deal of thinking. Hospitals are hiring doctors to practise roentgenotherapy. They are hiring the radiologist to carry on not only the radiologic practice of the hospital, but they are opening the doors of the hospitals to anyone from outside practice who wants to come in to have radiologic work done.

That can lead to only one thing. It is absolutely in line with the practice that is gaining headway in a good many parts of the country of hiring a radiologist to do certain work, letting the hospital make and collect the fees. It is only the opening of the door to the time when they will hire a surgeon on salary to do the emergency work and let the hospital make the fees and collect for that emergency work. Then they will have somebody hired to do the emergency medical work. It is only a question of time until there will be a practising of medicine by the hospitals.

As to identification of films in a legal case in which the technician has left employment and cannot be located: in one such case, by identifying the teeth which happened to show in the film, we were able to prove that it was the film of that particular patient.

I would like to state that, in going upon the stand to testify, I do not qualify myself as a radiologic expert. I qualify myself as a physician who is expert in radiology. One of my colleagues almost got into trouble for contempt of court, because, when he was first put on the stand, he neglected to state in his qualifications that he was a physician and that he practised medicine. They had him up there as a "picture taker." It serves some of us right to be put up as such, when we continue to talk about "pictures."

DR. S. A. CLARK (South Bend, Ind.): I just want to correct one statement that the essayist made in regard to the question of the courts having passed upon the ownership of the films.

In last week's (Nov. 21, 1931) issue of the *Journal of the American Medical Association* appeared this article: "The question of whether the roentgenograms of the hospital patient belonged to the patient or to the hospital was answered by a court for the first time, so far as is known, in Hurley Hospital *vs.* Gage, decided on appeal April 21 by the Circuit Court of the County of Genesee, Michigan. . . . In giving judgment the court pointed out that the hospital sold and the patient paid for, not the material that went into roentgenograms, but knowledge and experience. The protection of the hospital might depend largely upon the proper preservation of the roentgenograms, and, said the court, 'the films should remain with the hospital.' Judgment was given against the patient for the balance due on his bill."

DR. S. C. BARROW (Shreveport, Louisiana): I want to speak strictly from one angle, and what I say will be really more a discussion of Dr. Case's discussion than of the paper.

In all branches of medicine I think we realize that we need have no fear for future scientific development so long as the medical profession is permitted to manage its business as it, and it only, knows how it should be managed. That is applicable to the various specialties in medicine.

Personally, I have never seen the right, or the justness, or the appropriateness of the

American College of Surgeons' standardizing the X-ray department of a hospital, any more than I have seen the appropriateness of the American College of Physicians' doing it. I was glad to see that the American Medical Association, which is really the one to control this standardization, has taken at least a step in that direction.

Personally I am here to suggest that organized radiology take over the standardization of radiologic practice in hospitals. I believe that the time has come, and really passed, when we should do it for organized radiology of America. At least it would be more appropriate that radiology do so than any other organization which has undertaken it.

It is a notorious fact (and I am speaking now from direct knowledge) that over the whole country there are hospitals in which the X-ray department is being operated by a radiologist who is operating directly in competition with himself.

That is a situation which cannot be overcome unless someone else than ourselves overcomes it. There are numbers of men who cannot disconnect themselves from the hospitals for financial reasons. Because of that, they have to submit to a financial situation which is embarrassing, to say nothing of unethical. I mean that certain hospitals in this country are using the X-ray department, reducing fees, or giving a schedule of fees which the same operator of that department cannot put into effect in his office. The hospitals are using the X-ray departments because it is appealing to any industrial organization to be told, "We will give you your X-ray services for 50 per cent of what is usually charged." They know they are going to make up the low cost in another department.

I do not charge those hospitals with directly violating their consciences as they see the situation. You and I operate that department when the hospital has a contract with corporations to do their work for a fee that we cannot charge in a private laboratory, because we have no other means of charging that patient, and the hospital has.

Therefore, I feel very strongly that organized radiology should take this up, and, if it does not, the situation is going to continue to grow worse. I do not think, as Dr. Case said, that there will ever be any chance of a hospital employing a surgeon and in that way removing the surgeons from private practice. The surgeons are not going to stand for that. We need not look to it.

As concerns the contacting of the local representative of the American College of Surgeons, who standardizes or reports on conditions, we cannot do that. That is a too roundabout way, and each man is attending to the business to which the organization should attend. It is a deplorable situation and an unethical one. It is a situation that we should get from under as quickly as possible. I hope that organized radiology will come forward and assert itself and take action in the business that is its own.

DR. R. R. NEWELL (San Francisco, Calif.): The ideal is for us to be consultants, and, if we are going to be consultants, we must act as consultants. One of the best ways to train our physician friends to treat us as consultants is to be available, and also to use the telephone.

It seems to me that our official relation to the hospital ought to be, as nearly as possible, the same as that of the other physicians and surgeons. If the surgeons in the hospital have their own private practices, and if the physicians in the hospital conduct their own private practices, then the radiologists should be conducting their private practices in the hospital. I admit that it is financially difficult, because the radiologist feels that he cannot, in a good many cases, afford to install expensive apparatus in the hospital. Nevertheless, the most dignified relationship between the radiologist and the rest of the medical profession is that in which the radiologist is exactly on the same financial and professional basis as others in the profession. A salary does not afford that, and a percentage arrangement does not afford that in the highest degree possible. I know several radiologists who have decided that radiology is well conducted in a hospital. They conduct their private practice in the hospital and have

financial arrangements with the hospital concerning the necessary free work.

The hours of service were well enough put, but in the matter of emergencies it seems to me that it is not a sufficient service merely to provide a technician. That is a duty for the radiologist himself to perform, I believe.

DR. BEILIN (closing): Irrespective of opinion, the subject is very important. One hears numerous complaints from physicians who are practising in general hospitals.

The first point that I wish to emphasize again is that the radiologist should impress on the attendants in the institutions in which he is practising, by his conduct and by the management of his practice, that he is not a roentgen photographer, but a consultant. Therefore, the roentgenologist should consult whenever possible with every attending physician who comes to see him in his department. He should, as Dr. Case has stated, desire to find out what the problem is. He is not interested merely in the examination of the chest or of the gastro-intestinal tract. He is interested to see if he can be of help in eliciting a diagnosis, because diagnosis is the primary idea of the physician who is referring the case.

In regard to the question of requisitions, I feel the idea expressed by Dr. Case is an excellent one; but in institutions in which one has a fair amount of work, it is important that one shall have a standard form of requisition. Our reason for demanding specific statements in filling out requisitions is to avoid errors in examinations.

We take a history of every patient who comes into our department, because we want to know something about the clinical condition of that patient. We do not care particularly what he is going to be examined for. We want to try to make a diagnosis of what he is complaining of.

We take the history for two purposes: first, to be familiar with the clinical complaint, and, secondly, to see if the examination which is requested will elicit the complaints of the patient. If the doctor has ordered a gastro-intestinal examination, and if we find the gastro-intestinal tract is normal, we may then advise an examination of the genito-urinary tract, if the clinical symptomatology indicates.

DR. NEWELL: Who takes the history of the patient?

DR. BEILIN: The resident in the department, or one of the nurses. My technicians, who are all nurses, have been in my department for many years, and some of them are able to take a history as well as some physicians.

The assistants in the department study a set of questions pertaining to various clinical conditions which come to the roentgenologic department. At the beginning, the nurse refers to the typewritten questions relating to a certain examination. After a while she becomes familiar with all the cardinal symptoms pertaining to a certain disease so that a trained nurse in one's department is able to take a fairly competent history.

I agree that the size of an institution will present an individual problem. One must also take into consideration the fact that a roentgenologic department may have been inadequately managed before one has taken charge of it. The new director's first problem may be to straighten out the situation. It should be emphasized that the roentgenologic department is the roentgenologist's problem. It should be borne in mind that superintendents of hospitals have their own problems, and, as a rule, they are going to try to manage the entire institution as they see fit. In handling the professional and business administration of my department, I make it my business to know what the superintendent of the institution and board of trustees have in mind and what they expect.

In regard to the statement made by Dr. Clark, I am familiar with what happened in the State of Michigan. I have that little extract before me, but I was speaking about jurisprudence in the State of Illinois.

I also agree with what Dr. Newell has said about emergency examinations in particular. But I cannot agree with the point that, when an individual is sent in by an attending physician, say at 10 or 11 o'clock at night, with a fracture, the director of the department should

interpret the findings for the physician at that time. If the attending physician is not familiar with the roentgenologic interpretation of bones, the roentgenograms can well be interpreted the following morning. We do not allow any of our assistants, except a physician who is the resident in the department, to make an interpretation of an examination in the absence of the roentgenologist. Many cases said to be emergencies are not. If one has reasonable rules for handling emergency cases, it will be unnecessary for his assistants to make roentgenographic examinations at all hours during the night.

Growth of Cancer-like Chicken Tumor Checked by Dyes.—Scientists who have been studying chicken tumors in the hope of throwing light on the problem of cancer in man have for the first time been able to destroy the activity of one of the chicken tumor-producing agents by means of dyes, it appears from a report of Dr. Margaret Reed Lewis and Warren Reed Lewis, of the Carnegie Laboratory of Embryology, Johns Hopkins Medical School, to the *American Journal of Cancer.*

Dyes are now used by some scientists to kill certain disease-causing organisms, such as the streptococci, and recently dyes have been tried in the treatment of cancer, although unsuccessfully. The Baltimore investigators wondered what the effect of dyes would be on chicken tumors. Viruses have been the subject of intense investigation in recent years, but so far it has been almost impossible to destroy the activity of any virus by a dye as can be done for larger, microscopic organisms. It is not known whether the virus is a living organism or a chemical substance.

The Lewises extracted the virus from one of these chicken tumors so they could work with it in a test tube. They combined it with eighty different dyes. After being mixed with the dye, the virus was injected into the chicken to see if it could still produce a tumor. Two of the eighty dyes destroyed the tumor-producing activity of the virus. However, the investigators pointed out that the activity was destroyed in the test tube by an amount of dye which would be impractical to inject directly into the animal in the hope of destroying the tumor-virus in its body.

They consider eighty dyes a small number to have investigated. They feel from the results of their study that when a larger number of dyes are investigated, it may be possible to find more than two which can prevent the growth of tumors even when used in more dilute concentrations. Experiments on injecting the dye directly into the chickens suffering from this type of tumor are now being planned.

The world of science is already familiar with the studies of cell growth and cancer on which Dr. Margaret Reed Lewis has collaborated with her husband, Dr. Warren H. Lewis, and it is interesting to note that in this latest investigation she had the assistance of another member of her family, her son, Warren Reed Lewis, now a medical student.—*Science Service.*

THE RADIOLOGIST AS A CONSULTANT[1]

By JOHN F. HERRICK, M.D., F.A.C.S., F.A.C.R., Ottumwa, Iowa

IT should be the aim of the radiologist to be considered a consultant in medicine. Too often he has accepted the rôle of technician, permitting his knowledge of medicine and surgery, as well as his knowledge of the science and art of radiology, to be submerged. His duty should not end with a simple report of structural findings. He should be able to analyze the findings in the light of the history and symptoms, to correlate them, and then give his conferee an opinion of practical value.

The radiologist has to do with two classes of physicians: (*a*) those who do not desire an opinion from him, and (*b*) those who are desirous of obtaining any aid possible.

In the first class are those who, because of opportunity and experience, feel that they are quite competent to interpret the findings themselves. To them, the radiologist is little more than a technician. Others seem so jealous of their prerogatives that they undertake to make their own interpretations and diagnoses, notwithstanding their want of knowledge of the science of radiology. This class is hopeless. It is just as well to allow them, with the help of the technician, to make what they can of their work.

The second class, those who are conscious of their limitations, realize that they are not so well qualified to interpret fluoroscopic findings or X-ray films as those who make a special study of radiology. If the radiologist is to be a helpful consultant to this group, he must be able to interpret his findings in the light of physical conditions and physiologic variations, and to discuss them with his conferee as would a consulting physician or surgeon. Not until then may he hope to take the place in medicine that rightfully belongs to him.

It is not an uncommon experience for the radiologist to be called upon to explain his findings. If he is well informed in medicine and surgery, he will be able to put the matter in such form that the physician may grasp its significance and apply it in the management of the case.

For instance, a patient is sent to the radiologist to seek for the cause of distressing abdominal symptoms. The radiologist finds no evidence of organic disease of the gastrointestinal tract. He sees a normally filling and emptying gall bladder, etc., but he does find a spastic colon which interferes with the normal function of that organ. A careful search having failed to reveal an organic cause, it becomes apparent that the etiology of the condition must be neurologic. Such cases are not uncommon; they are the source of grief to the attending physician. We see a number of such cases that, after going through some of the best known clinics, are sent home with a negative diagnosis to bring added woe to the home doctor. If the radiologist who handled the case were versed in physiology, he would be able to explain the nature of such a case to the referring physician and to suggest the possibility of securing relief by the prolonged and persistent use of belladonna, nux vomica, and cascara. The radiologist might make of the suffering, wretched patient, a happy, useful citizen, and win the gratitude and good-will of the attending physician.

A similar case may be made out for the gall bladder. A sense of gaseous distention, epigastric distress, and numerous other symptoms are the occasion for a radiologic examination of the gall bladder and its function. With such marked symptoms, often

[1]Read before the Radiological Society of North America, at the Seventeenth Annual Meeting, at St. Louis, Nov. 30–Dec. 4, 1931.

the gall bladder will fill and empty normally; again it may fill but fail to concentrate, or it may not be so much a failure in concentration as it is a failure of the liver to secrete the dye in the allotted time.

Such cases are often reported as diseased gall bladder when the disease is in the liver itself. Cholecystectomy fails to give relief, much to the embarrassment of the attending physician and surgeon. If the radiologist had in mind a correct history, if he had observed the coated tongue, foul breath, and muddy sclera, and had determined the extended time it took the liver to secrete the dye, all indications of a diseased liver, such a suggestion to the attending physician might prompt him to a course of treatment which would greatly benefit the patient, and, if surgery was necessary, lessen the mortality.

The radiologist may be asked to find in the chest the cause of a persistent cough. There may be no other symptoms, and physical examination of the chest may fail to locate the cause. Perhaps X-rays may also fail to show evidence of disease of the lungs, yet the cough persists. It often happens that a careful follow-up examination will reveal chronic cholecystitis or hepatitis. In such cases, slight pressure over the gall bladder or heavy percussion over the right costal cartilages will provoke the cough. Branches of the vagus nerve, which supplies the gall bladder, also serve the bronchi. Irritation at one point may cause reflex action at another; so, in this lesion, one may find cough, asthma, etc., as a result of disease of the gall bladder. Another not uncommon result of gall-bladder disease is cardiac disturbance through the vagus connections. Relief of hepatic or cholecystic disease will, in many cases, do more to relieve irregular or rapid cardiac action than any treatment directed to the heart alone.

It may be said that some of the conditions mentioned have no connection with roentgenology. They have not, from the technician's point of view. But the medical roentgenologist, as stated above, must be a true and helpful consultant if he wishes to occupy the position in the profession which he should. In order to do this, he needs a full and comprehensive knowledge of general medicine and surgery, especially of anatomy and physiology. Equipped with this knowledge, without intruding himself on his conferees, he may become so valuable an aid that his services will be much more in demand, to the advantage of the patient and to the satisfaction of the physician in charge.

DISCUSSION

DR. G. E. PFAHLER (Philadelphia, Pa.): I think the sooner we, as radiologists, place ourselves in the position of consultants, the better off we will be, the better off the patient will be, and we will be making real progress in medicine.

I have always considered myself a consultant. Occasionally I have met men who thought I had exceeded my limitations. But, unless we consider ourselves physicians first of all, and make our radiologic practice secondary or a part of that position as a physician, we degenerate very rapidly to the position of technicians.

In every one of our cases, it is our duty to add anything to the case, or any information to the referring physician, that will help to get that patient well. After all, the patient is sick, the patient wants help. If we have an idea that may be helpful to that patient, it is our duty to express it to the referring physician, but not to the patient, just as any consultant would do. Sometimes those suggestions will be of value in proportion to our knowledge of general medicine. Therefore, it is our duty, as radiologists, to learn just as much about general medicine as we can, to learn the general practitioner's problems. Because if the radiologist interprets those problems only in the light of our technical knowledge the general practitioner does not get the effect. We must interpret in the light of the practising physician and his problems, and

primarily with the object of helping the patient to get well.

In doing that, we must be careful not to give the clinician orders; in other words, we must not assume the direction of the case. I mean, when we make an examination of the patient, it is our duty to describe our findings or give a record of our observations—what we observe in the roentgen examination, fluoroscopically and from the film findings—and then, distinctly separated from it, our interpretation in the light of the clinical knowledge which we have concerning that patient.

I have frequently said that a condition may be due to this, or that, or that there are two, three, or four possibilities in the case which must be further interpreted in the light of clinical evidence at hand. If I had some of that clinical evidence, I would say that such and such evidence would point to Number 1 as the most likely cause of the condition. I even go further. If I have in mind anything that will be helpful in getting the patient well, I believe it is my duty as a radiologist to make any suggestion. The man in charge can throw away all my advice if he chooses.

Gamma Rays and X-rays Have Different Effects.—More exact knowledge of the differing biological effects of radiations used in treating tumors and other diseased conditions was urged upon medical experimenters and practitioners by Dr. G. Failla and Dr. P. S. Henshaw, of Memorial Hospital, New York City, in speaking before the American Association for the Advancement of Science. They described a series of experiments in which they tested the effects on various living things of equal-energy doses of X-rays and gamma rays from radium. The effects tested included the extent of slowing-down of wheat seedlings, percentage of killing in insect eggs, and degree of skin erythema.

In one series of "shots" it was found that parallel doses of X-rays and of gamma rays slowing down the growth of the shoot of wheat seedlings to the same extent had different slowing effects on other parts of the plant and on other objects. The gamma rays were 29 per cent more effective than the X-rays in slowing down root growth and 36 per cent more deadly to insect eggs; but they were 57 per cent less effective in causing artificial sunburn.

This latter point is of some importance in practical medicine, for the effectiveness of a given dose of radiation on a tumor or other tissue under treatment is usually judged by the redness of the overlying skin. But in the experiment the more destructive rays had the lower skin-reddening power, showing that unless the quality of radiation is taken into account the skin-reddening effect cannot be very closely relied on as an index to its other effects.—*Science Service.*

ELECTRICAL DEFINITIONS

Final Report of Subcommittee No. 13—Radiology

of

SECTIONAL COMMITTEE ON ELECTRICAL DEFINITIONS

of

AMERICAN STANDARDS ASSOCIATION

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The following definitions are submitted by Subcommittee No. 13, Radiology, and constitute a final report. This is a revision of the original report, circulated May 14, 1931, and printed in RADIOLOGY, October, 1931, page 800.

GROUP 75—RADIOLOGY

Section .05—General Terms

Radiology *75.05.005*

Radiology is the branch of science that relates to roentgen rays, radium rays, and other high frequency rays.

Radiologist *75.05.010*

Radiologist is a medical specialist in employing roentgen rays and/or radioactive substances.

Roentgenology *75.05.015*

Roentgenology is the branch of science that relates to the application of roentgen rays for diagnostic or therapeutic purposes.

Roentgenography *75.05.020*

Roentgenography is the art of producing roentgenograms.

Radiography *75.05.025*

Radiography is the art of producing radiographs.

Radiation *75.05.030*

Radiation is the radiant energy emitted by an X-ray tube, by radio-active substances, or by other sources.

Roentgenogram *75.05.035*

(Skiagraph)* (Skiagram)*

Roentgenogram is a photographic record of the relative transparency of the various parts of an object to roentgen rays.

Radiograph *75.05.040*

(Radiogram)*

Radiograph is a record produced on a photographic plate, film, or paper by the action of roentgen rays or radium.

Note: There seems to be no good reason for continuing the use of this word as here defined. "Roentgenogram" and "curiegram" fully cover the two senses which are included in this definition.

Fluoroscopy *75.05.045*

(Roentgenoscopy)

Fluoroscopy is the use in diagnosis, testing, etc., of a fluorescent screen which is activated by roentgen rays.

GROUP 75—RADIOLOGY

Section 10—Kinds of Rays

Roentgen Rays *75.10.005*

(X-rays) (Röntgen Rays)

Roentgen rays are electromagnetic

*Deprecated.

waves of very short wave length which are set up when the velocities of electrons are altered suddenly.

According to the quantum theory of the nature of radiation, roentgen rays are particles of energy (quanta) travelling linearly at the velocity of light.

Note: "Roentgen rays" is preferred by medical authorities, but "X-rays" is in more general use by physicists. The wave lengths concerned are usually between 0.006 and 1.0 millimicron.

Secondary Roentgen Rays *75.10.010*

Secondary roentgen rays are the roentgen rays emitted in all directions by any matter irradiated with roentgen rays.

Scattered Roentgen Rays *75.10.015*

Scattered roentgen rays are roentgen rays which, during their passage through a substance, have been deviated in direction and also may have been modified by an increase in wave length.

Characteristic Roentgen Rays

Characteristic Spectra *75.10.020*

Characteristic roentgen rays are roentgen rays having wave lengths determined by the atomic constitution of the object which emits, transmits, or scatters them.

Fluorescent Roentgen Rays *75.10.025*

Fluorescent roentgen rays are secondary rays whose wave lengths are characteristic of the substance which emits them.

Cathode Rays *75.10.030*

Cathode rays are streams of electrons emitted from the cathode of an evacuated tube normal to its surface, under the influence of an applied voltage.

Note: By suitable means they can be brought outside of the tube.

Lenard Rays *75.10.035*

Lenard rays are cathode rays which have passed outside the discharge tube.

Positive Rays *75.10.040*

(Canal Rays)

Positive rays are streams of positive ions travelling at high speed from the anode of a partially evacuated tube.

GROUP 75—RADIOLOGY

Section 20—Physical and Industrial Applications

Radiometallography *75.20.005*

Radiometallography is the radiography of metals.

X-ray Crystallography *75.20.010*

X-ray crystallography is the study of the arrangement of the atoms in a crystal by the use of roentgen rays.

Filtration of Roentgen Rays *75.20.015*

Filtration of roentgen rays is the absorption of some of the rays of relatively long wave length by placing in the path of the beam an absorbing medium such as copper or aluminum.

X-ray Spectrum *75.20.020*

X-ray spectrum is the orderly arrangement according to wave length of a heterogeneous beam of roentgen rays.

Minimum Wave Length *75.20.025*

(Quantum Limit)

Minimum wave length is the shortest wave length in an X-ray spectrum. It is definitely related to the maximum voltage applied to the X-ray tube in accordance with the Planck-Einstein quantum equation.

Absorption Coefficient *75.20.030*

Absorption coefficient is the ratio of the linear rate of change of intensity of roentgen rays in a given homogeneous material to the intensity at a given point.

Half Value Thickness *75.20.035*

(Half Value Layer)

Half value thickness is the thickness of a given substance which, when introduced in the path of a given beam of rays, will reduce its intensity to one-half of the initial value.

GROUP 75—RADIOLOGY

Section 25—Medical Terms

Radiotherapy *75.25.005*

Radiotherapy is the treatment of dis-

ease by the application of roentgen rays or the rays from radio-active substances.

Roentgentherapy *75.25.010*

Roentgentherapy is the treatment of disease by roentgen rays.

Radiumtherapy *75.25.015*

Radiumtherapy is the treatment of disease by the use of radium, radon, or its active deposit.

Irradiation *75.25.020*

(Raying)*

Irradiation is the application of roentgen rays, radium rays, or other radiation to a patient or other object.

GROUP 75—RADIOLOGY

Section 40—Tubes

Discharge Tube *75.40.005*

Discharge tube is a vessel of insulating material (usually glass) which is exhausted to a low gas pressure, and which permits the passage of electricity through the residual gas upon application of sufficient voltage.

Note: The tube is usually provided with metal electrodes, but one form permits an electrodeless discharge with induced voltage.

Gas Tube *75.40.010*

Gas tube is a discharge tube which depends on the presence of residual gas in the tube for the supply of electrons.

Vacuum Tube *75.40.015*

Vacuum tube is a vessel of insulating material (usually glass) provided with metal electrodes, which has been so highly evacuated that the residual gas does not affect the current between the electrodes.

X-ray Tube *75.40.020*

X-ray tube is a device for producing roentgen rays, embodying (1) an airtight enclosure exhausted to the proper degree of vacuum; (2) a suitable electrode, forming the cathode, from which electrons are liberated; (3) a second electrode electrically insulated from the first, forming the anode or target upon which the electrons impinge after being set in motion by the action of the applied voltage.

Cathode-ray Tube *75.40.025*

(Lenard Tube)

A cathode-ray tube is a discharge tube with a thin window at the end opposite the cathode to allow the cathode rays to pass outside.

Geissler Tube *75.40.030*

A Geissler tube is a special form of discharge tube for showing the luminous effects of discharges through rarefied gases.

Note: The density of gas is roughly one-thousandth that of the atmosphere.

Crookes Tube *75.40.035*

Crookes tube is an early form of discharge tube devised by Sir William Crookes and used by him for the study of cathode rays.

Note: The density of gas is roughly one-millionth that of the atmosphere.

Hot Cathode Tube *75.40.040*

Hot cathode tube is a vacuum tube in which the cathode is electrically heated (usually to incandescence) in order to increase the emission of electrons.

Hot Cathode X-ray Tube *75.40.045*

Hot cathode X-ray tube is a vacuum X-ray tube in which the electron stream is supplied by a heated cathode.

Note: The cathode stream may be regulated by varying the current through the cathode filament.

Target *75.40.050*

(Anode) (Anti-cathode)*

Target is the electrode on which cathode rays are focused and from which roentgen rays are emitted. It is usually of a heavy metal such as tungsten.

Cathode Dark Space *75.40.055*

(Crookes Dark Space)

Cathode dark space is the non-luminous region which envelops and follows the

*Deprecated.

outline of the cathode in a discharge tube at moderately low pressures.

Negative Glow *75.40.060*

Negative glow is the luminous glow which envelops the cathode in a discharge tube at moderately low gas pressures.

Valve Tube *75.40.065*

A valve tube is an electric valve consisting of a vacuum tube having for one electrode a hot filament.

GROUP 75—RADIOLOGY

Section 45—Other Apparatus

X-ray Machine *75.45.005*

X-ray machine is an assembly of electrical devices necessary to activate an X-ray tube and control its operation.

X-ray Apparatus *75.45.010*

X-ray apparatus is an X-ray tube and its accompanying accessories, including the X-ray machine.

Electrostatic Generator *75.45.015*

(Influence Machine) (Static Machine) (Wimshurst Machine)

Electrostatic generator is a device which depends upon electrostatic action for the production of electric charges.

Induction Coil *75.45.020*

(Coil) (Spark Coil) (Ruhmkorff Coil)

Induction coil is a transformer with open magnetic circuit which is excited by an interrupted or variable current.

Interrupter *75.45.025*

[Break (of an induction coil)]

Interrupter is a device for interrupting the primary current mechanically or otherwise.

Fluorescent Screen *75.45.030*

Fluorescent screen is a sheet of suitable material coated with a substance which fluoresces visibly when roentgen rays, radium rays or electrons impinge upon it.

Fluoroscope *75.45.035*

(Roentgenoscope)

Fluoroscope is a device consisting of a fluorescent screen suitably mounted, either separately or in conjunction with an X-ray tube, by means of which X-ray shadows of objects interposed between the tube and the screen are made visible.

Intensifying Screen *75.45.040*

Intensifying screen is a thin screen, coated with a finely divided substance which fluoresces under the influence of roentgen rays, and intended to be used in close contact with the emulsion of a photographic plate or film for the purpose of increasing the effect on the film.

X-ray Spectrometer *75.45.045*

X-ray spectrometer is an instrument for producing an X-ray spectrum and measuring the wave lengths of its components.

Ionization Chamber *75.45.050*

Ionization chamber is an enclosure containing two or more electrodes between which an electric current may be passed when the inclosed gas is ionized. It is commonly used for determining the intensity of roentgen rays and other ionizing rays.

Penetrometer *75.45.055*

(Qualimeter) (Radiosclerometer)*

Penetrometer is an instrument for indicating the hardness of roentgen rays.

Dosage-meter *75.45.060*

(Dosimeter) (Intensimeter)

Dosage-meter is an instrument designed to estimate the quantity of radiation, so as to determine the duration of exposure when using roentgen rays for therapy.

Roentgenometer *75.45.061*

(Roentgen meter) (Ionometer)

Roentgenometer is an instrument for measuring the quantity or intensity of roentgen rays.

Oscilloscope *75.45.065*

Oscilloscope is an instrument for making visible the presence and/or the nature

*Deprecated.

and form of oscillations or irregularities of an electric current.

Note: There are several different types of instrument serving this general purpose which have been designated by this name.

GROUP 75—RADIOLOGY

Section 60—Characteristic Terms

Hardness *75.60.005*

[Quality (of Roentgen Rays)]

Hardness is the attribute which determines the penetrating ability of roentgen rays. The shorter the wave length, the harder the rays and the greater their penetrating ability.

Hardness (of a gas tube) *75.60.010*

Hardness is the degree of rarefaction of the residual gas.

Note: The higher the vacuum, the higher the voltage required to cause a discharge with a cold cathode, and hence the shorter the wave length of the resulting roentgen rays.

Intensity (of Roentgen Rays) *75.60.015*

Intensity is the attribute of a beam of roentgen rays which determines the rate of ionization of air at a given point, under the conditions stipulated in the definition of roentgen. (See 75.60.025.) It is expressed in roentgens per unit of time.

Quantity of Roentgen Rays *75.60.020*

(Quantity of X-radiation)

Quantity is the product of intensity and time.

Note: It should be clearly understood that quantity is used here in a sense different from that customary in other fields, such as radiant energy in general. It is not proportional to energy, but, rather, to the product of energy density and a coefficient expressing the ability to cause ionization.

Roentgen *75.60.025*

Roentgen is the international unit of quantity of roentgen rays adopted by the Second International Congress of Radiology at Stockholm in 1928. It is the quantity of X-radiation which, when the secondary electrons are fully utilized and the wall effect of the chamber is avoided, produces in one cubic centimeter of atmospheric air at 0 deg. cent. and 760 mm. of mercury pressure, such a degree of conductivity that one electrostatic unit of charge is measured at saturation current.

GROUP 75—RADIOLOGY

Section 95—Not Otherwise Classified

Ionization *75.95.005*

Ionization is the process by which neutral atoms or molecules become charged, either positively or negatively.

Ionization Current *75.95.010*

Ionization current is the electric current resulting from the movement of electric charges produced by the action of an applied electric field upon an ionized medium.

THE EFFECTS OF ULTRA-VIOLET, X-, AND CATHODE RAYS ON THE SPORES OF *MUCORACEÆ*

By BASILE J. LUYET, Sc.D., Rockefeller Institute for Medical Research, NEW YORK CITY

THE experiments about to be described are preliminary observations of the effects of X-rays, of cathode rays and of ultra-violet light upon the development and growth rate of spores of the fungus *Rhizopus nigricans* +. As such they form part of a study being carried out in this laboratory of the action of these radiations upon a variety of simple organisms.

TECHNIC

The experimental arrangements for producing and measuring the radiations have already been described.[1] The cathode-ray tube, of Coolidge type, was operated at a potential difference of 155 kilovolts. In these tests no estimation was made of the number of electrons striking the irradiated surface but the dose was roughly that used in earlier studies on bacteria. The soft X-ray beam, from a copper target tube, was filtered through thin nickel foil and consisted mainly of the Cu Kα line ($\lambda = 1.537$ Å.). Its air ionization as measured at the surface of irradiation was 130 E.S.U. per second. Ultra-violet light of a single wave length was obtained with a powerful mercury lamp and a large monochromator. The approximate energies in the several beams used, as found from readings of a standardized thermocouple, were: for 2,536 Å., 8 ergs/mm.^{2}/sec.; for 2,652 Å., 9 ergs/mm.^{2}/sec.; for 2,900 Å., 11 ergs/mm.^{2}/sec.; for 3,132 Å., 48 ergs/mm.^{2}/sec. In all cases care was taken to have the intensity of radiation as uniform as possible over the exposed region. This was determined by the use of fluorescent screens and, more sensitively, by the requirement that the biological effects be the same on different parts of the irradiated surface.

Before irradiation the original culture was inoculated to test tubes containing Coon's agar medium. After two weeks' growth at 22° C. to insure that the only spores present were mature and resting, a suspension of them was prepared in the nutrient solution. The surfaces of Petri dishes poured with Coon's agar medium were inoculated with the suspension thoroughly shaken and stirred to break up the sporangia. Areas on these plates were irradiated as soon as the spore-bearing solution had dried into the agar. After incubation for 24 hours at 22° C., a count was made, under the microscope, of the total number of spores on a given area and of the number of those which showed growth. Similar counts upon unirradiated areas gave the percentage of cells which failed to develop under normal conditions. Applying this correction the survival ratios of Table I were obtained. At the same time estimates were made of the average length of mycelial growth 24 hours after different dosages with radiation. This was accomplished by drawing under known magnification and with a suitable eyepiece the mycelia of sprouted spores. Tracings of the resulting lines with the wheel of a planimeter then determined the total length of mycelium due to a given number of spores. Results of this count, averaged to give the mycelial length of one spore, are recorded in Table II and Figure 2.

DISCUSSION

The survival ratios with all three types of radiation give similar multiple-hits-to-kill curves when plotted on semilogarithmic paper (Fig. 1). Evidence for the progressive

[1] R. W. G. Wyckoff and T. M. Rivers, Jour. Exp. Med., 1930, LI, 921; R. W. G. Wyckoff, ibid 1930, LII, 435; R. W. G. Wyckoff and B. J. Luyet, RADIOLOGY, December, 1931, XVII, 1171-1175.

stages of injury implied by these curves is to be seen in the arrested growths of Figure 2.

Comparison of their killing curves shows that these spores are much more resistant than yeast cells.[2] At the point of 50 per cent killing, for example, it takes about twice as many cathode rays, about three times the soft X-ray energy and as much as six times the ultra-violet energy to prevent development of the fungus spores as it does to destroy yeast cells.

Many of the spores in preparations which have been subjected to cathode rays for from one-half to two minutes swell to giant size without ever producing mycelia. Sometimes they reach nearly five times their initial diameter; they are translucent and do not take on the brownish color and cytolyzed appearance of dead cells. Most of them stop growing within a day after irradiation. Besides the giant spores without mycelia, others are found which, growing short mycelia before their development ceases, represent all transition stages towards normal cells. X-rays and even ultraviolet light produce this effect but much less markedly. The presence of swollen spores obviously makes it difficult to set up the accurate criterion of death necessary for obtaining significant survival ratios. In making the counts of Table I a cell has been taken as dead if it fails to develop as much as a mycelial beak.

It should also be remarked that no evidence whatsoever has been found of a stimulative effect from small doses of radiation.[3]

The writer is indebted to Dr. Ralph W. G. Wyckoff, in whose laboratory the present experiments were carried out, for many suggestions and for help in the preparation of this note.

[2] R. W. G. Wyckoff and B. J. Luyet, *op. cit.*

[3] G. Nadson and G. Philippov, Compt. rend. Soc. de biol., Feb. 10, 1928, XCVIII, 366-368.

TABLE I.—SURVIVAL RATIOS FOR SPORES OF *Rhizopus nigricans*

For Cathode Rays										
Time (seconds)	16	32	60	120	240					
Ratios	1.00	0.65	.59	.35	0					
For X-rays										
Time (minutes)	10	15	25	40	50	60	70	90	100	
Ratios	1.00	0.96	.89	.87	.61	.51	.19	.11	.02	
For Ultra-violet Light, $\lambda = 2{,}536$ Å.										
Time (minutes)	5	10	15	20	25	30	35	40	50	60
Ratios	1.00	0.99	.77	.69	.45	.23	.20	.11	.08	.02
For Ultra-violet Light, $\lambda = 2{,}652$ Å.										
Time (minutes)	4	5	8	10	13	16				
Ratios	1.00	0.98	.49	.16	.06	0				
For Ultra-violet Light, $\lambda = 2{,}900$ Å.										
Time (minutes)	10	15	20	25	30	35	40			
Ratios	1.00	0.87	.59	.34	.15	.12	.05			
For Ultra-violet Light, $\lambda = 3{,}132$ Å.										
Time (minutes)	30	45	60	90						
Ratios	1.00	0.87	.61	.46						

TABLE II.—AVERAGE LENGTH OF MYCELIUM DEVELOPED BY AN IRRADIATED SPORE

For Cathode Rays									
Time (seconds)	0	4	8	16	32	60	120		
Length (mm.)	2.21	1.32	0.89	.64	.31	.09	.02		
For X-rays									
Time (minutes)	0	5	10	15	20	30	40	50	60
Length (mm.)	2.17	0.56	.32	.28	.19	.16	.14	.08	.05
For Ultra-violet Light, $\lambda = 2{,}652$ Å.									
Time (minutes)	0	1	2	4	5	7.5			
Length (mm.)	1.94	0.63	.46	.29	.17	.09			

SUMMARY

Spores of the fungus *Rhizopus nigricans* have been irradiated with cathode, X-, and ultra-violet rays. Survival ratios with each type of radiation give curves which indicate that more than one hit or quantum absorp-

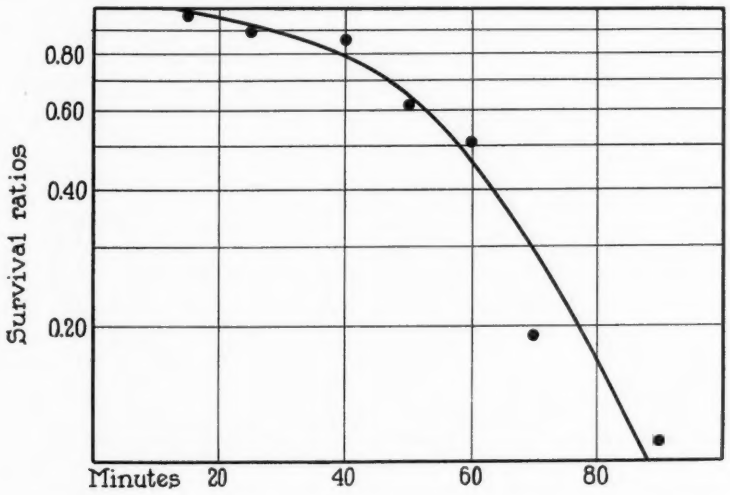

Fig. 1. The survival ratios of the spores of *Rhizopus nigricans* under the action of copper Kα X-rays. Similar curves are given by the other radiations.

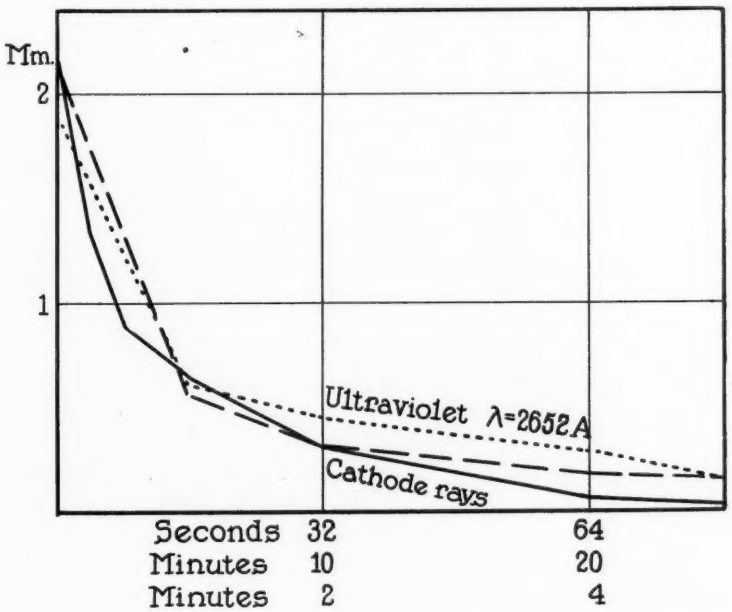

Fig. 2. A plot of the data of Table II, showing the average mycelial length of irradiated spores.

tion is necessary to kill. Measurements have also been made of the decrease in growth occasioned by sub-lethal doses of each radiation.

The production of giant cells which ultimately die without undergoing further development has been noted. They become most numerous under cathode rays and are least often seen after ultra-violet irradiation. No evidence has been found that small doses of any of these radiations are stimulative.

Electrons Speed within Dense Solids.—A method used by astronomers to determine the velocity of stars has been applied in a slightly modified form to the atom to furnish the first direct evidence that electrons, negatively charged electrical portions of atoms, move about at high speeds in solid bodies.

The experiment, conducted at the California Institute of Technology by Dr. Jesse W. M. DuMond, research fellow, and Dr. Harry A. Kirkpatrick, teaching fellow in physics, was the second crucial test of activities of the electrons within the atom. The first test was reported in January, 1931.

In explaining the application of the Doppler effect to the experiment, Dr. DuMond declared that if the source of the light or sound is in motion the successive vibrating waves or ripples are crowded together on the forward side of the motion's direction, and spaced farther apart on the rearward side.

A similar phenomenon explains the fact that the sound from a train whistle approaching a stationary listener is of higher pitch than the sound of the same whistle when the train is receding from the listener. In the same way, stars approaching an observer emit spectral lines shifted toward the violet end of the spectrum, whereas receding stars emit lines shifted toward the red.

When the electron scatters X-radiation a similar effect occurs. If that part of the radiation which is scattered at a definite angle to the incoming beam is observed with a spectroscope, the spectral line which was in the original radiation is found to be shifted toward longer wave lengths and the spectral line is found to be broadened. The shift may be regarded analogically as a Doppler effect caused by the velocity of the electron recoiling away from the light under the impact that the light has given it. The increased breadth of the line may be regarded as a composite Doppler effect of the chaotic motion of all the electrons in the myriads of atoms scattering the X-radiation.

Dr. DuMond set the average speed of the invisible electrons which make up solid matter at 1,500 miles per second for the case of carbon. The experiment not only throws more light upon the internal activities of an atom, but proves two predictions made by Dr. DuMond in 1929. These were: first, that in the spectrum of X-rays scattered by solids of low atomic number the breadth of the Compton shifted line would be proportional to the sine of one-half the scattering angle; second, that it would be proportional to the primary wave length.

The latest experiment testing the second of the above predictions was conducted with the multi-crystal spectrograph developed at the California Institute of Technology. Measurements were made of characteristic X-rays from molybdenum, silver, and tungsten scattered by carbon at an angle of 156 degrees. Spectrum photographs were made of the radiation from each element. Each exposure lasted 1,000 hours.

Dr. DuMond based his predictions two years ago upon the hypothesis that the breadth of the shifted line in the spectrum of scattered X-rays is caused by the movement of electrons in atoms. The fulfillment of the two predictions is, therefore, confirmatory evidence for the hypothesis on which they were based.—*Science Service.*

DIAGNOSTIC PNEUMOTHORAX

AN AID IN THE DIAGNOSIS OF PLEURAL TUMORS

By WILLIAM B. FAULKNER, JR., M.D., Department of Surgery, University of California Medical School, SAN FRANCISCO, and EDWARD C. FAULKNER, M.D., Department of Thoracic Surgery, St. Mary's Hospital, SAN FRANCISCO

EVEN for those who constantly see large numbers of patients with varied diseases of the chest, it is not always easy to differentiate pleural tumors from those within the lung and mediastinum. In addition it may be difficult to say with any degree of certainty which of these patients probably can be helped by surgical measures and which are beyond surgical aid. We have been faced by this problem on more than one occasion. We have seen instances in which physical examinations, plain roentgen studies, iodized oil injections, and bronchoscopic examinations either failed entirely to establish the exact diagnosis or left us uncertain as to which patients could be helped by operation, which type of operation to select, and which method of anesthesia to employ. Hence our enthusiasm in the use of a procedure which furnishes this information. Such a procedure is diagnostic pneumothorax.

In its clinical trial since its introduction by Brauer (1), in 1912, it has stood the test of usefulness (2, 3, 4, 5) and we feel that it should be adopted by a greater number of those interested in the study of intrathoracic disease. This is especially true inasmuch as diagnostic pneumothorax furnishes valuable information, is relatively safe and easy to perform, and does not aggravate the patient's condition.

The technic depends on whether or not there is an associated pleural effusion. In the absence of pleural fluid, the air usually is introduced under local anesthesia by a method similar to that employed in the treatment of pulmonary tuberculosis. A midaxillary intercostal space is selected as the point of puncture, unless pleural adhesions are present at this point. If the tumor is situated in the axillary region, a point of puncture on the anterior chest wall should be selected, so as to avoid the danger of perforating the tumor.

Usually from 250 to 500 c.c. of air will be sufficient to give the desired information, but occasionally slightly larger or smaller amounts may be necessary. We have had occasion to use as much as 1,000 and as little as 100 c.c. of air. In general, the total amount employed is determined by the intrapleural pressure, the vital capacity, and the subjective reaction of the patient. When the intrapleural pressures are negative (normal), the pneumothorax can be induced with safety; but the pressures must be rechecked after the introduction of every injection of from 25 to 50 c.c. of air. This permits discontinuance of the pneumothorax before the pressure becomes positive. In

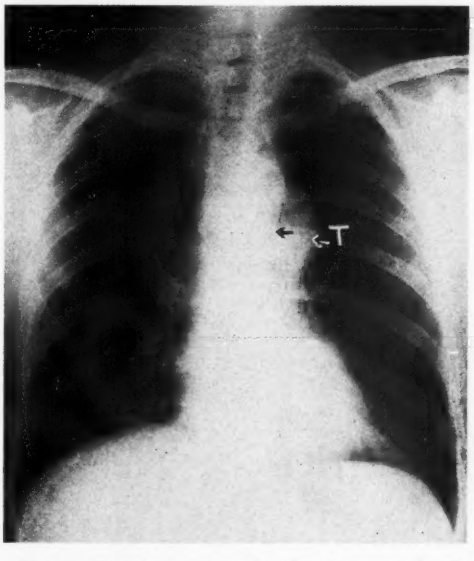

Fig. 1. Roentgenogram showing a tumor in the hilus region. From this plate one cannot say whether the tumor is in the mediastinum, lung, or parietal pleura. *T*—tumor; *unlettered arrow*—aorta.

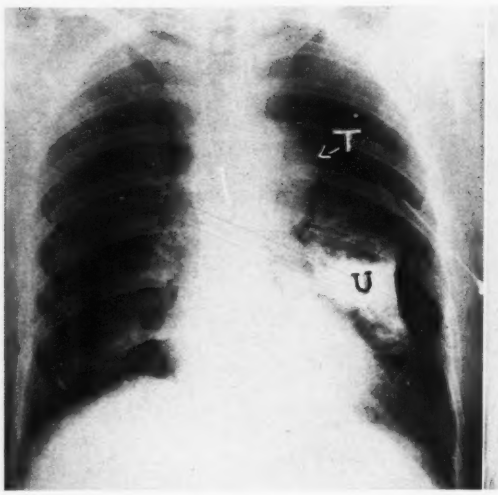

Fig. 2. Same patient as in Figure 1. Diagnostic pneumothorax roentgenogram taken at the end of inspiration. *U*—left upper lobe containing iodized oil is displaced downward by the pneumothorax. Arrows indicate the tumor *(T)* which is not attached to the lung.

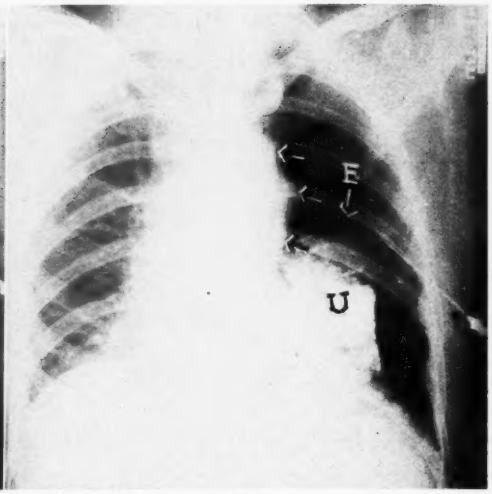

Fig. 3. Same patient as shown in Figure 2. Plate taken at the end of forced expiration. The unlettered arrows indicate the tumor which has moved toward the sound side. Compare with Figure 2. *U*—upper lobe containing campiodol (iodized oil); *E*—edge of displaced upper lobe.

patients in whom the initial manometer readings fail to show the normal fluctuation, or indicate a positive intrapleural pressure, no air at all should be introduced. Similarly, extreme pain, undue anxiety, dizziness, shortness of breath, or unusual subjective reactions should be taken as indications for the discontinuance of the pneumothorax regardless of the amount of air that has been introduced at the time the symptoms appear. These precautions lessen the likelihood of tearing pleural adhesions and producing pulmonary trauma, spontaneous pneumothorax, empyema, and cerebral air embolus. In the debilitated, and in those with a decidedly lowered vital capacity, much smaller amounts of air are to be employed and especial caution is to be observed during the induction of the pneumothorax.

If a pleural effusion is present which interferes with the roentgen visualization of the suspected tumor, it would be both faulty and dangerous to remove all the fluid and then attempt the introduction of air into the pleural cavity. Such a technic leads to sudden alterations in the intrapleural pressure, produces sudden and marked changes in the position of the heart and mediastinal structures, and leaves the patient liable to

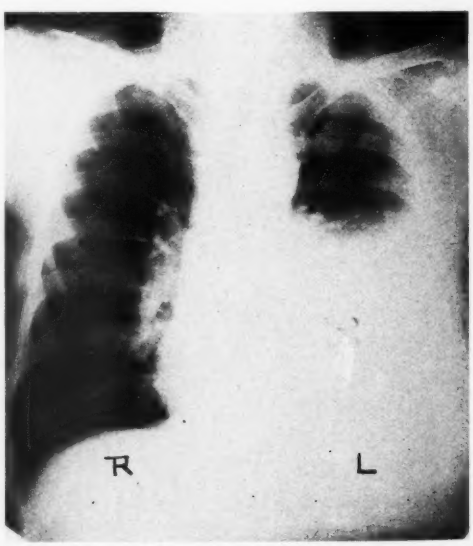

Fig. 4. Roentgenogram before diagnostic pneumothorax.

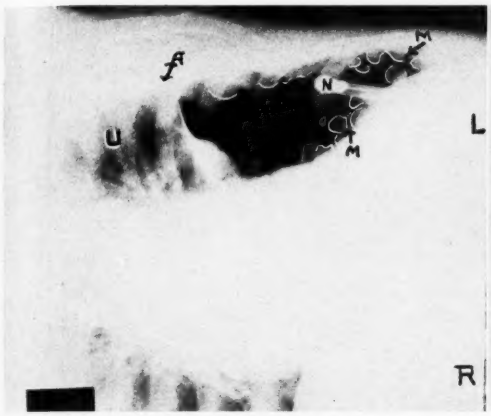

Fig. 5. Diagnostic pneumothorax roentgenogram of same patient as in Figure 4. (Plate taken with patient lying on right side.) *M*—Nodular masses involving the lower two-thirds of the pleura and the diaphragm; *U*—upper lobe adherent to lateral chest wall at *A*; *N*—Needle and cannula in place so that the air can be removed at the completion of the roentgen studies.

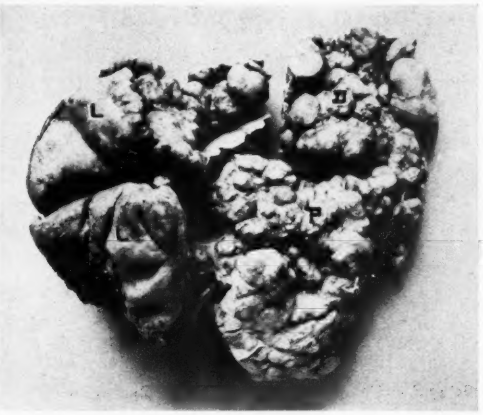

Fig. 6. Specimen from the same patient as shown in Figures 4 and 5. *L*—Lung; note the nodular masses of various sizes and shapes on the diaphragm, *D*, and pleura, *P*.

severe respiratory and circulatory disturbances. A thoracentesis should be performed; but, if severe disturbances are to be avoided, each syringeful of fluid should be replaced at once by an equal amount of air.

After the introduction of the air, the patients are examined fluoroscopically and X-ray plates are made with the patient in various positions. The aim of these various postures is to allow the air to collect at the areas that we wish to study. Most often, the anteroposterior, lateral, horizontal, and Trendelenburg positions suffice; but, in exceptional cases, it is advisable to employ additional postures. The initial fluoroscopic examinations not only determine the positions best for the taking of the X-ray plates, but also indicate the presence or absence of pleural adhesions, the amount of mediastinal movement, and the influence of respiration upon the position of the tumor. As will be shown, these factors are important in differentiating pleural tumors from those within the lung or mediastinum.

In the absence of pleural adhesions and when the patient is in the erect position, the pneumothorax displaces the lung downward, medially and away from the costal pleura. The air serves as a contrast medium so that tumors of the parietal pleura stand out in bold relief. Their position is unchanged following pneumothorax, or upon postural changes of the patient, inspiration or expiration. On the other hand, pulmonary tumors

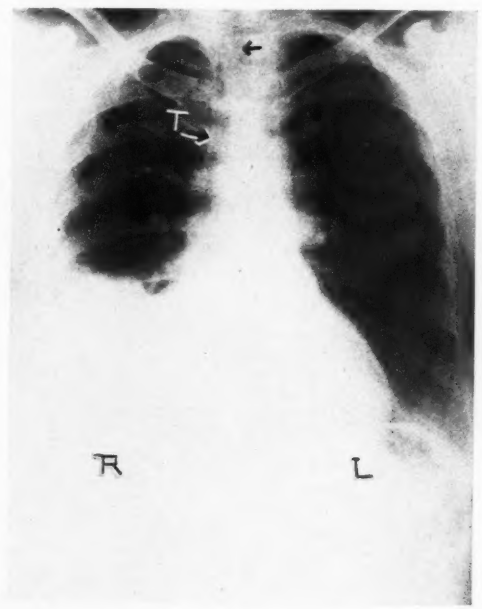

Fig. 7. Plain roentgenogram of patient with suspected pleural tumor. *T*—Trachea displaced to the right.

are displaced by the air. They change their position with changes in the posture of the patient, move toward the pneumothorax side on inspiration, and return toward the opposite lung on expiration. Mediastinal tumors

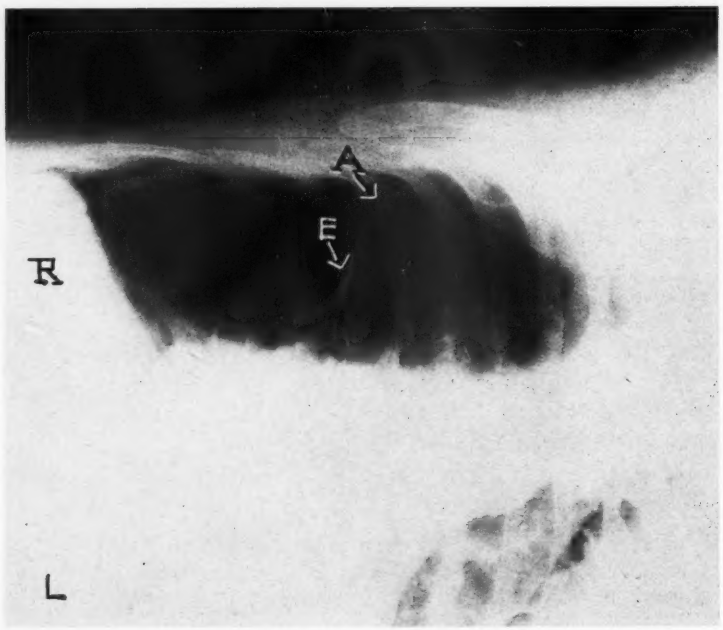

Fig. 8. Diagnostic pneumothorax roentgenogram (same patient as shown in Figure 7); horizontal position. The pleura is smooth and shows no evidence of a growth. *E*—lung edge; *A*—adhesions to lateral chest wall.

are much less often displaced downward or upward by the air, their only appreciable movement being the swing toward the pneumothorax side on inspiration and the return on expiration (Figs. 1, 2, and 3).

CASE REPORTS

The practical value of diagnostic pneumothorax was well demonstrated in two of our recent cases.

Case 1. In a male patient, aged 60 years, who complained of chest pain, dyspnea, and weakness of three months' duration, the physical findings and plain X-ray films pointed to an effusion at the left base; the thoracentesis revealed a serosanguineous exudate, which was removed and replaced by air. The roentgenogram taken, following the introduction of air, indicated that the condition was more than a simple hemothorax, for the parietal pleura was involved by large nodular masses (Figs. 4 and 5). From these plates it was evident immediately that this was not a case for surgery and the prognosis was established as decidedly bad. X-ray treatments were employed but the patient died a few months later. A comparison of the pneumothorax roentgenograms with the pathologic specimen indicates clearly the value of pneumothorax in accurately localizing pleural tumors and in determining the cases that are suitable or unsuitable for surgery (Fig. 6).

Case 2. In another elderly patient, a pleural tumor had been suspected following the usual clinical examinations, but the diag-

nostic pneumothorax demonstrated that the pleural surface was smooth and without evidence of a growth. This was confirmed later at necropsy (Figs. 7 and 8).

For each of the foregoing patients, an exploratory thoracotomy had been considered seriously; but, following the diagnostic pneumothorax, the correct diagnosis, the extent of the involvement, and the unsuitability for operation were established. Accordingly, both patients were spared unnecessary surgical procedures.

DISCUSSION

As with other diagnostic procedures, pneumothorax has its limitations, largely because of pleural adhesions which may be so generalized that no air at all can be introduced or so situated as to interfere with the displacement of the lung and mediastinum. In such cases, an exact pre-operative differential diagnosis cannot be made by this method. In many other instances, pneumothorax will be of service and will supplement the other accepted methods of investigation. By determining the site and extent of adhesions and the mobility of the mediastinum, pneumothorax guides the way in the selection of proper surgical approach and choice of anesthesia for the individual patient.

In patients who present definite indications for surgery, the air may be left in the pleural cavity so that the patient can adjust himself gradually to the changes which would otherwise occur suddenly during the opening of the thorax. If a two-stage operation is planned, with suture of the lung to the parietal pleura at the initial operation, the air should be withdrawn before the surgical procedure.

Generally speaking, there are two rules to observe. When patients have no associated pleural effusion, as much air may be withdrawn as was introduced. This is not true when there is an extensive pleural effusion. In these cases, only enough air should be removed to permit the trachea, heart, and mediastinal structures to return to their normal positions. This can be determined rather satisfactorily by palpating the trachea and by percussing the area of cardiac dullness; but the safest and most accurate guide during air withdrawal is the manometric registration of intrapleural pressure. The pressure should not be allowed to become more negative than —6 c.c. of water on expiration and —12 on inspiration, because, if too much air is removed, the mediastinal structures will be drawn toward the involved side and serious and alarming symptoms may ensue.

CONCLUSIONS

1. The term "diagnostic pneumothorax" is used to designate the introduction of air into the pleural cavity for diagnostic purposes.

2. The procedure is safe, relatively easy to perform, and does not aggravate the patient's condition.

3. Diagnostic pneumothorax is of definite value in the differentiation of parietal pleural tumors from those within the lung and mediastinum.

4. It furnishes essential information in the selection of chest cases for operation; and it indicates the type of anesthesia and surgical approach that will be best fitted to the individual case.

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MEDIASTINAL PLEURISY[1]

CASE REPORTS AND X-RAY DIAGNOSIS

By HENRY SNURE, M.D., Los Angeles, California

WHILE mediastinal pleurisy is not a frequent lesion, it is probably more often overlooked or incorrectly diagnosed than any other pleural condition. Unless an X-ray examination is made, it is not often diagnosed until rupture into a bronchus or other organ of the chest occurs, this latter complication being frequently a serious one. However, mediastinal pleurisy was known and diagnosed in Laënnec's clinic long before the roentgen era. Both the dry and serofibrinous types of mediastinal pleurisy are occasionally overlooked by X-ray methods but these heal practically spontaneously without permanent injury to the patient. The nontuberculous type of purulent effusion may be fatal unless surgical intervention is begun early and drainage established. It would seem that the pure pneumococcus type of effusion is about the only form that can rupture into a bronchus and the patient survive, this rupture usually taking place within a twenty-day period.

The index of the Surgeon General's Library and the Cumulative Index of the American Medical Association list 53 papers dealing with mediastinal pleurisy, most of which are in the French and German literature. The papers of Devic and Savy, 1910 (1), and of Savy, 1910 (2), are the ones to which reference is most often made. Worthwhile papers in the American journals are those of Frick (3), and of Sagel and Rigler (4). A considerable number of the recent foreign papers deal with conditions simulating mediastinal pleurisy, such as bronchiectasis and childhood tuberculosis. Dolley (5) has recently collected 106 cases from the literature. Because the actual number of case reports is small, three are included in this paper.

Several classifications have been suggested for mediastinal effusions, the one most commonly used describing the location of the effusion as right or left, anterior or posterior mediastinum. Combinations of the foregoing occur, and at times a further division into upper or lower has been made. Another classification divides mediastinal effusions according to the type of exudate: serofibrinous (tuberculosis), hemorrhagic (tuberculosis, trauma, tumor), and purulent (tuberculosis, tumor, trauma, pneumonia, mediastinitis). The mediastinal effusions are encapsulated mesially by the mediastinal pleura and laterally by the pulmonary visceral pleura. When extension occurs to the sinuses of the pleural cavity, it is designated as the costomediastinal type by Herrnheiser (6). Barjon (7) alludes to a so-called hilus type and describes three cases.

A good description of the clinical syndrome is given by Dieulafoy, quoted by Rose (8). Dieulafoy states: "Mediastinal pleurisy starts as an acute febrile attack with pain, fever, cough, and dyspnea. The symptoms caused by pressure on the mediastinum are dyspnea, stridor, sucking in of chest wall, dysphagia, distention of the veins of the chest, fits of coughing and suffocation, hoarseness, dysphonia, and spasm of the glottis. All, or only some, of the symptoms may be present, due to whether the pressure is on the trachea, esophagus, azygos vein, the pneumogastric or recurrent laryngeal nerve." The clinical sign of dullness, usually posterior, appears about the tenth day. Voice changes should suggest a bronchoscopic examination. The pneumo-

[1]Read before the Radiological Society of North America at the Sixteenth Annual Meeting at Los Angeles, Dec. 1–5, 1930.

coccus type of effusion is ushered in by sudden onset and high temperature; if rupture into a bronchus occurs, the discharged material is thin in consistency and does not have a foul odor.

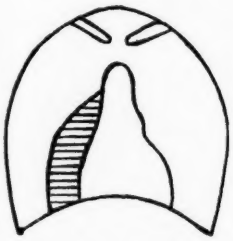

Fig. 1. Right anterior mediastinal pleurisy. *(Devic and Savy.)*

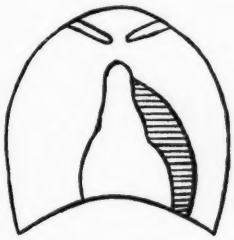

Fig. 2. Left anterior mediastinal pleurisy. *(Devic and Savy.)*

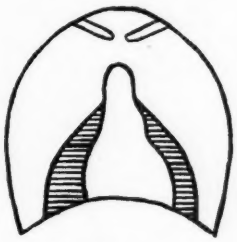

Fig. 3. Right and left anterior mediastinal. *(Devic and Savy.)*

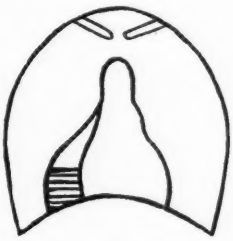

Fig. 4. Right anterior, with pyopneumothorax. *(Devic and Savy.)*

Roentgen technic consists of a thorough fluoroscopic examination of the chest followed by films made not only in the usual positions but also in such other positions, as indicated by the fluoroscopic examination, as will best visualize the pathology under consideration. Over-exposed films are useful in doubtful cases, especially left-sided effusions (Fig. 6) that might be obscured by the heart shadow. Injection of a small amount of air at the time diagnostic puncture was made proved to be of great aid in one case observed by myself. Destot (7) suggests the inflation of the stomach with air when pericardial and mediastinal effusions are to be differentiated because pericardial effusion causes bulging of the shadow into the air bubble of the stomach. The barium meal will rule out dilatation, diverticula, or ulcerating carcinoma of the esophagus.

The differential diagnosis of tumors and mediastinal pleurisy is sometimes difficult as both usually have convex borders extending into the lung area; however, tumors and enlarged glands are more likely to be in the hilus area and the effusions to be nearer the diaphragm. The effusions high in the chest may resemble cysts (Fig. 8); however, cysts are more circular in outline and are not apt to extend to the opposite side. Infected cysts have caused effusions. Whereas the shadow of pericardial effusion is of even density, in mediastinal effusion the heart can be definitely outlined within a larger shadow, and pulsation is not of much help unless it is one-sided. Ruggles (9) states the sign of greatest value is the paradoxical movement of the heart with forced respiration which occurs when mediastinitis is present. While cold abscesses are visualized as fusiform shadows including the spine, pleurisy is usually on one side, with no destruction of the vertebræ present. Assmann (10) illustrates a tuberculous type that has a concave lung border instead of the usual convex border; however, tuberculosis as a rule is diagnosed by clinical methods, and X-ray evidence of the disease is often present in other parts of the chest. Mediastinal pleurisy may become interlobular and then rupture into a bronchus, as described by Schinz (11). Rupture into a bronchus is well shown by Sante (12), who also presents diagrams showing interlobular extension. The heart shadow is not often displaced. Aneurysm and substernal thyroid have at times caused confusion. Assmann found several typical shadows of mediastinal pleurisy that at postmortem were proved to be indicative of some other lesion. On the right side, a vena cava inferior simulated the tuberculous type; on the left side,

a large fat pad at the apex of the heart was confusing; again a typical posterior left-sided triangular shadow, paravertebral in

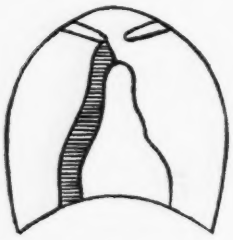

Fig. 5. Right posterior, paravertebral type. *(Assmann.)*

Fig. 6. Left posterior, tuberculous origin. *(Assmann.)*

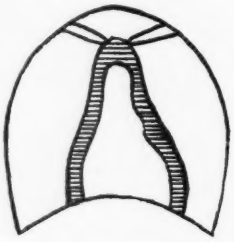

Fig. 7. Early right and left posterior. *(Devic and Savy.)*

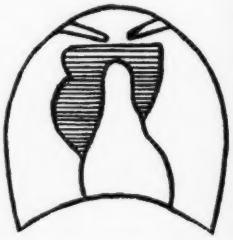

Fig. 8. Right and left posterior mediastinal. *(Groedel.)*

position, visualized through the heart shadow, was found to be a densely infiltrated extra lobe of the lung. Lenk (13) also illustrates a typical right-sided mediastinal pleurisy that later proved to be a neurofibroma of the right vagus nerve. Groedel (14) reports a case of non-infectious mediastinal collection of fluid, namely, a hemorrhage into the right posterior mediastinal space following penetration of the chest by a granite splinter. He also illustrates an unusual case of right upper posterior mediastinal effusion that extended to the left posterior mediastinal space in its upper portion. In this latter case effusion did not extend much below the hilus area.

I have compiled a chart (Figs. 1-8) showing the most common types of mediastinal pleurisy, although combinations are not unusual. These diagrams are copied from text-books and authors' names are appended. Diagrams were made of my own cases (Figs. 9-11) because direct prints from the films failed to bring out the proper contrast.

CASE REPORTS

Case 1. H. E., male, age 31 years, entered the hospital on Jan. 21, 1929, complaining of a persistent, non-productive, painful cough; stabbing sharp pains in the lower right chest; dyspnea; very rapid pulse, and post-influenzal asthenia.

Clinical examination revealed an advanced mitral stenosis and myocarditis. Moist râles were present over both lower lobes, as was dullness on percussion on the right side of the heart anteriorly and posteriorly. Except for a few days after admission, the man's temperature was continuously under 99 degrees. Respiration was almost constantly at 24. The pulse was very irregular, often reaching 120.

During his stay in the hospital the leukocyte count varied between 13,000 and 15,000, with 80 to 85 per cent polymorphonuclears. On admission, the urine contained an occasional hyaline cast. Casts and albumin increased gradually up to the time of death. The blood cultures were negative.

The first films (Fig. 9) of the chest showed a sharply defined shadow along the right cardiac border, with a small amount of free fluid in the left costophrenic angle. The right diaphragm was of normal curvature and excursion, with no free fluid in the right costophrenic angle. The shadow gradually enlarged and a diagnosis of right posterior mediastinal pleurisy was made. About 300 c.c. of purulent material, which gave a pure culture of *Staphylococcus aureus*, was removed from the right poste-

rior mediastinal area. The shadow had almost disappeared three days after surgical drainage, only a few stringy lines radiating from the hilus region remaining. Ten days later the films showed no further changes.

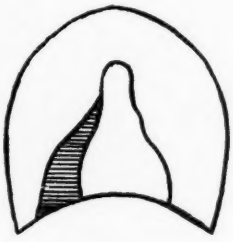

Fig. 9. Right posterior, Case 1.

Fig. 10. Right posterior, Case 2.

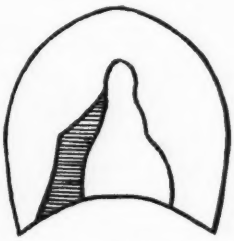

Fig. 11. Right posterior, Case 3.

The patient died of acute dilatation of the heart three weeks after surgical drainage and seven weeks after admission to the hospital. Autopsy was refused.

Case 2. H. S., male, age 23 years, grocer, entered California Hospital on Nov. 3, 1929, complaining of pain in the right chest at the level of the eighth rib in the axillary line, also coughing of the non-productive type. The history was of sudden onset two weeks earlier. There were no physical signs on admission.

The urine contained a trace of albumin. The respiration varied between 20 and 25 throughout the course of the infection. The pulse rate was practically fixed at 95. The temperature varied from 99 to 101 degrees. On admission, the leukocyte count was 11,300, with 68 per cent polymorphonuclears; from November 15 to 19 the pulse rate increased to 100, temperature to 103 degrees, and the leukocytes gradually increased from 12,000 to 25,000, with 86 per cent polymorphonuclears. Surgical drainage was then instituted and laboratory findings soon returned to normal, but a slight discharge continued for about four weeks after operation.

X-ray examination on admission showed the lower half of the right chest area to be increased in density and this density changed with position. A clear, straw-colored fluid to the amount of 500 c.c. was aspirated in the axillary area. Cultures from this fluid remained sterile. X-ray examination a few days after aspiration showed no free fluid in the costophrenic angle, but a sharply defined shadow (Fig. 10) was present along the right side of the mediastinum. This shadow increased in size for one week, extending to the right posterior chest wall. Aspiration posteriorly at the level of the right transverse process of the seventh dorsal vertebra yielded 160 c.c. of pus containing Gram-positive cocci in chains and pairs. Surgical drainage was instituted at the site of puncture. Many small cavities separated by soft adhesions were found to be present between the mediastinal pleura and the pulmonary visceral pleura. The adhesions were broken down until one large cavity existed, but great care was taken not to involve the parietal pleural cavity. Complete recovery took place six weeks after operation.

Case 3. M. P., female, age 9 years, entered the hospital on March 7, 1929, complaining of a painful cough which began three weeks earlier, following a cold.

Examination revealed dullness on the right side of the heart posteriorly as far as the inferior angle of the scapula. Ante-

riorly it was continuous with liver dullness. No râles were present.

On admission the leukocyte count was 16,800, with 78 per cent polymorphonuclears, gradually dropping, twelve days later, to 9,000, with 75 per cent polymorphonuclears. Smears for bacilli of tuberculosis were negative. The temperature was below 100 degrees at all times. The pulse varied greatly, frequently up to the rate of 120. The respiration varied between 20 and 30.

X-ray films (Fig. 11) on admission showed a sharply defined triangular shadow with its base on the diaphragm in the right cardiophrenic angle, posterior in location. The right diaphragm had a normal curvature and excursion, with no free fluid in the costophrenic angle. Five days later, the triangular shadow was seen to have increased about 25 per cent in size. One week after this second examination no change in size was demonstrated but the patient was much improved clinically. The child was discharged one week after this X-ray examination as cured and has had no recurrence of symptoms since.

COMMENT

It will be noted that in all three cases the temperature, pulse rate, and leukocyte count were only slightly increased. All patients had a non-productive cough, with pain on the right side. The symptoms were of several weeks' duration before admission to the hospital. At first, these patients were placed in bed at home and treated as ordinary pleurisy cases; if X-ray examinations had not been made the true conditions would not have been discovered. Cases 1 and 2 were proven by operation. Case 3, when viewed in the anteroposterior plane, resembled the anterior type of effusion (Fig. 1), which is explained by Herrnheiser as due to extension to the costomediastinal sinus, quite common in posterior types of mediastinal effusions. Case 3 did not resemble a collapsed lower lobe as there was no compensatory emphysema in other lobes, nor did it resemble a collapsed lobe with bronchiectatic cavities, as suggested by Stoloff (15). The shadow remained of even density, increased in size for one week, and then showed a small interlobular extension. Tuberculosis was not demonstrated before or after the effusion occurred.

In all obscure chest conditions it is well to keep the possibility of mediastinal pleurisy in mind, and, for the present, at least, these cases should be reported. No doubt many cases of mediastinal pleurisy have been overlooked in the past.

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VIENNA ROENTGENOLOGIC SOCIETY

SESSION OF APRIL 14, 1931

Chairman: PROFESSOR G. SCHWARZ
Secretary: DR. PRESSER

Professor Kienböck and Professor G. Schwarz were elected Chairmen of the Vienna Roentgenologic Society. Professor H. H. Berg, Dortmund, and Privatdozent G. Herrnheiser, Prague, were elected corresponding members. Professor G. Schwarz took the chair and delivered an address in memory of Professor Dr. Martin Haudek, deceased.

Martin Haudek is gone from our midst. The morning of March 9, we received the sad news that this apparently perfectly healthy man, with happy disposition, had suddenly passed away. Haudek succumbed within a few minutes to an attack of angina pectoris, the harbingers of which had sounded a warning some time previously but had been unable to diminish to the slightest degree the creative force of this highly energetic man. Two days before his death, Haudek delivered a long address at the headquarters of the Public Health Service concerning the equipment for his newly erected Roentgen Institute in the Wilhelminenspital, to which he had devoted himself most completely during the previous months. There were no indications that all his magnificent plans were to be brought to an abrupt end. In Martin Haudek not only Vienna but international radiology has lost a representative of unusual make-up.

On the occasion of the death of its unforgettable member, the Wiener Röntgengesellschaft received many expressions of sympathy that revealed most eloquently though sorrowfully the extraordinary esteem in which Haudek's personality and Haudek's scientific accomplishments were held throughout the world. The communications came from the Deutsche Röntgengesellschaft, the Swedish Radiologic Society, the Vereinigung Deutscher Röntgenologen und Radiologen in Czechoslovakia, the Roentgen Association of the Union of Socialist Soviet Republics, and the president of the International Congress of Radiology in Paris; likewise from Prof. Hans Meyer, Bremen, and many other colleagues.

Haudek, before taking up roentgenology, had been associated originally with the department of internal medicine. After a course of thorough training in the Nothnagel Clinic and in the Weichselbaum Institut für Pathologie, Haudek became, in 1907, acting director of the Frisch department of internal medicine in the Vienna General Hospital. The inadequate nature of the status of gastric ulcer diagnosis brought him in contact with the method of roentgen examination, which at that time was just beginning to be developed, and awakened in him a special liking for our specialty, which grew stronger as time went on. On May 1, 1908, Haudek became associated with the Holzknecht Institute, where he developed his pre-eminent ability. Here Haudek, in collaboration with the Eiselsberg surgical clinic (Clairmont), developed his method for the demonstration of ulcerations of the stomach; here he worked out the symptom of the filling defect *(nischensymptom)*, which has been taken up by all textbooks throughout the world; here he elaborated the radiologic criteria for the differentiation of carcinoma from a benign ulcer, the radiologic indications for stomach operations, and other forms of technic.

During the World War, Haudek directed the roentgen institutes of several large hospitals, and also in these places carried on some valuable scientific researches on roentgenologic determination of the size of the

heart and the interpretation of heart roentgenograms; on chronic bone suppurations, and the roentgenologic diagnosis of internal diseases. In 1920, Haudek became director of the roentgen institute in the Vienna Wilhelmina Hospital. In addition to the further development of gastro-intestinal diagnosis, he devoted himself here chiefly to researches on the course of healing processes in pulmonary tuberculosis, to which medicine is indebted for new and valuable disclosures.

In the field of therapeutics, likewise, Haudek's restless mind was active, to mention only the important publications on the roentgen treatment of exophthalmic goiter, and irradiation treatment of conditions following operations on the digestive tract.

All the works of Haudek are characterized by perfect linguistic expression, keen logic, and unerring judgment as to what is important from the medical point of view. Haudek was right in not regarding roentgenology as a subordinate, merely technical adjuvant procedure whose province is to furnish purely mathematical or purely formal findings, as, for example, the chemical and microscopic research method, but as an all-embracing medical specialty equal in every way to other specialties. He never grew tired of emphasizing this point of view in smaller and in wider circles and in impressing it on his followers. He was an outstanding teacher, and his pupils have carried his fame and the reputation of the Vienna radiologic school to the ends of the earth. Equipped by nature with a remarkable flow of language, a ready wit, and an engaging personality, Haudek was destined to score many triumphs in scientific assemblies, whether serving as chairman, as essayist, or as leader of the discussion. His inherent capacity for organization, for establishing useful connections, for composing differences with wisdom, firmness, and moderation, made him everywhere, within a short time, a leader in both word and action. Since 1913, Haudek had been a permanent member of the executive committee of the Deutsche Röntgengesellschaft, and at the assembly in 1926 served as its chairman. We who have been intimately associated with Haudek will never forget the energy and judgment he displayed in preparing for the congress of Vienna in 1929. The giant task, which necessitated countless sessions with the representatives of all manner of boards and corporations and with individual interests, was solved by Haudek with pre-eminent success. Beloved by reason of his affability and his kindliness, and esteemed by all classes, he knew how to use his unusual popularity, just when it was needed, in the service of our specialty. He whose early passing fills us with deep sorrow was one of those figures for which there is no substitute, and whose merits and outstanding qualities are handed down to posterity, not merely for the exaltation of the deceased but also for emulation by his followers. Honor be to his memory! [The members of the assembly rose from their seats.]

HAUDEK'S SCIENTIFIC WORK
DR. FLEISCHNER

The task assigned to me, to speak on the scientific work of my teacher, has been made more difficult by an unfortunate event that has occurred at the last moment. Professor Holzknecht,[1] who was to have spoken on the discovery of the significance of the filling defect, has been taken ill, and there is no one who can present the subject as well as he. My paper will have to be a combination of narrative and readings, and it will consequently lack the spontaneity that Professor Holzknecht, as an eye-witness and participant, might have injected into it.

It was the important period of the first development of the application of roentgenologic methods to the diagnosis of gastro-intestinal disorders. Many valuable facts

[1]Professor Holzknecht did not recover.

had been learned since the use of the Rieder bismuth paste. Except for a few isolated, far-from-frank observations, peptic ulcer defied roentgenologic diagnosis. It was the discovery of diverticulum-like shadow spots in the silhouette of the stomach that Haudek (at first purposely avoiding any anatomic inferences) designated the "niche" (later known in English as the "filling defect"). A wonderfully exact roentgen analysis and description of findings (considering the technical aids that were then available), together with a few operative results, led him, within a very short time, to narrow down the diagnostic significance of the filling defect; to clarify it by connecting it with a number of signs or symptoms, and to announce it as the roentgenologic expression of the penetrative callous gastric ulcer. It was a period of feverish activity. Haudek was present at the operation on every patient that he had examined. Supplementary reports followed in quick succession. At the roentgenologic congress, held in April, 1910, he reported at first on only two cases; but when the Naturforscherversammlung was held in September, the number had increased to 17, and, two months later, there were 25 cases with 14 necropsy findings. In 1911, there appeared as the result of the collaboration with Clairmont, of the Eiselsberg Clinic, the monograph on the importance, for surgery, of roentgenologic diagnosis of stomach conditions, together with the publication of 35 clinicoroentgenologic case histories. It was a great disappointment for Haudek that a supplementary volume on the progress of gastro-intestinal diagnosis, which he had planned in collaboration with Holzknecht and which was almost ready for the printer, could not, for financial reasons, be published.

Haudek did not overlook the difference between the roentgen and the morphologic findings of ulcer. Little was known at that time about the anatomy of the living stomach, and the anatomy of the cadaveric stomach was a poor correlate to the roentgenograms. Hence he explained the diverticulum-like constriction of the filling defect on the part of the stomach as a circular spasm of the muscularis mucosæ. Through recent researches (Forssell) we have learned that a swelling of the mucosa surrounding the ulcer plays the chief part in this constriction. His further research had to do with the elaboration of the morphologic ulcer diagnosis and the differential diagnosis of ulcer and cancer. Even at that time we find Haudek's differentiation, which has now become famous: The ulcer is a heavier shadow and the cancer is a lighter shadow. Although deeply interested in the elaboration of the technic of the diagnosis of gastric functioning (Haudek had substituted the testing of the 6-hour remnant in place of the examination of a 24-hour remnant, and had introduced also the expeditious double meal procedure), yet, in his mental make-up, and, in part, doubtless also influenced by the constantly confirmed diagnostic significance of his morphologic ulcer symptom, he was not inclined to overestimate the value of functional manifestations. I go back in thought to the time when, inspired by the endeavor to learn more about the pylorus and the duodenum, one differentiated and classified, for want of reliable morphologic signs, the velocity and rhythm of gastric evacuation in a most delicate manner, and (from the standpoint of our present-day knowledge) drew venturesome diagnostic conclusions therefrom. Haudek endeavored at an early period to make the filling defect and the deformations of the bulbus the basis of his diagnoses.

We will not follow further the individual phases of his work. The World War found him engaged, in part, with other problems. Studies on the estimation of the degree of disability of persons affected with heart injuries; the results of bone injuries,

and, finally, the roentgenologic diagnosis of internal diseases, written for the practitioner, and appearing in Holzknecht's "Roentgenology," were the products of this period.

In the post-war period, after his transfer to the Wilhelminenspital, his collaboration with W. Neumann and Sorgo led him to make comprehensive studies on pulmonary tuberculosis. The fruits of this labor, as published in several articles, were, above all, the calling attention to the possible retrogression of tuberculous infiltrates of the lungs and to the retrogressive and healing capacity of extensive cavity processes, without surgical intervention. Haudek was one of the first roentgenologists to call attention to the necessity of differentiating the lung apex processes. On the basis of observations in large series of cases, he brought out the comparative insignificance of certain forms of tuberculosis of the apex. Passing over the large number of further articles dealing with the various fields of roentgen diagnosis and roentgen therapy, we will complete the circle by giving a more detailed account of his last researches in the field of stomach diagnosis. He began by laying the foundations and establishing the synthesis; further development and sifting characterized the closing arguments. With justified criticism, Haudek attacked the assertion that diagnostic errors of various practitioners were due to the unreliability of his filling defect symptom. Endeavoring to uphold the filling defect as a pathognomonic sign of peptic ulcer, he devoted himself indefatigably to the more delicate roentgen analysis of tumors that had broken down into ulcers. In his last extensive research on the changes in the pyloric gastric region, we find as a valuable diagnostic contribution the cancer stage or the subcardiac stage, and an exact morphology of the crateriform cancer-ulcer. From a large series of cases reported in detail, we learn here that the cancer crater forms what is usually an unevenly delimited shadow area within a filling defect, or, as Haudek called it, in precise terms, "a plus in a minus shadow." Whereas peristalsis usually passes unhindered over an ulcer, here the surrounding wall shows no peristaltic movements and forms by steps a contrast with the healthy stomach wall. The prepyloric filling defect, though not often observable, is a sharply demarcated shadow projection in the middle of a scutiform, smoothly contoured part of the stomach wall with a bay-like indentation. The fact that the canalis comes to a point is discussed in detail and its significance for the differential diagnosis is brought out. The difficulty and the frequent impossibility of distinguishing benign wall changes of the canalis from cancerous changes is emphasized. Especially this last great research, rich in carefully studied material extending over a long period of years, sifts, free from any preconceived intention of following any particular schema, the facts, and leads us, on the one hand, to unsuspected refinements of diagnosis, and shows us, on the other hand, the limits of our knowledge and insight. In this particular research we see Haudek, at the height of his activity, drawing from his incomparable experience, and whereas many older discoveries have long since become common property, this research permits us to recognize with no little chagrin how much Haudek might have taught all of us, if he had lived.

The chronologic study of Haudek's roentgenologic researches does not merely teach us many individual facts. We see from them—and I have observed it even more than others, owing to my collaboration with him for nearly ten years—that what gave the central direction to his researches was always primarily the clinical questioning. Haudek's principal endeavors began at the point where the clinician demanded a clarification of uncertain distinctions with reference to the treatment to be followed. From

the first to the last researches he always kept in mind the question of therapeutic indications, and he plainly limits and, at the same time, emphasizes the part that roentgen procedures must play. He always endeavored to test every technical measure to discover whether or not the required expenditure of time and means was justified by the anticipated success. He always sought to make his research technic as expeditious as possible and as little disturbing to the patient as was feasible. He regarded that as an essential requirement for the widest possible application of roentgen diagnosis in practical medicine.

Haudek's scientific work is not, however, exhausted in the publications that lie before us in completed form. In numerous addresses delivered at congresses and assemblies, and in many discussions he expressed thoughts and gave suggestions that he did not live to follow up and to develop. Not only to his close associates but also to countless physicians who came from far and near to see the master at his work, he always gave without stint out of his rich experience. He was a teacher of the old peripatetic type. One could plainly see him become animated by every kind of scientific discussion, even when dealing with the youngest members of the specialty. He was a good listener when others made their presentations, and, on the other hand, he was able to interest others in his own ideas. Taking it all in all, Haudek's work is a sheet-anchor of medical roentgenology and will remain a landmark in the history of medicine.

GRAWITZ TUMOR: ABRODIL ROENTGENOGRAMS

This demonstration concerns a patient aged 62, who, suffering from complete retention of urine and severe hematuria, sought aid at the urologic "ambulance" of Prof. Paschkis, and, after a thorough urologic examination, was referred to the Roentgen Institute. The speaker presented the intravenous pyelogram taken after injection of abrodil, in which normal excretory conditions of the contrast medium in the region of the left kidney are recognizable, while in the right field a filling defect is visible in the lower half of the renal pelvis. As the shadow of the right kidney is not plainly visible, a tumor is suspected, and that finding is strengthened by means of retrograde pyelography, which reveals likewise a filling defect in the right renal pelvis. Right nephrectomy was then performed by Prof. Paschkis. Result: a tumor of the right kidney of the Grawitz type.

CALCULUS OF THE RENAL PELVIS

A patient aged 42, after an attack of colic, sought aid in the urologic "ambulance." Prof. Paschkis sent him to our Roentgen Institute. The ordinary roentgenogram reveals, a finger-breadth to the left of the median line, at the level of the lower sacral vertebræ, a rough shadowy lobulated mass. (Suspicion of calculus.) As the position was atypical for a ureter stone (too far toward the median line), several roentgenograms with a sound were made, which the speaker presented. Finally retrograde pyelography was done, which revealed a dystopia of the left kidney, with a stone in the left renal pelvis. (Left-sided pelvic kidney with stone.) The demonstrated roentgenograms, taken by means of intravenous pyelography after injection of abrodil, confirm this supposition.

BILATERAL PELVIC KIDNEY, WITH STONE

The patient was a small, frail man who, at the time, noted only vague symptoms in the lower right abdominal quadrant, associated with bacterial pyuria. In the demonstrated plain roentgenogram, a large coral stone in the region of the right sacro-iliac

synchondrosis was to be seen. The application of the sound to the ureters and the use of retrograde pyelography revealed finally a bilateral dystopia of the kidneys (pelvic kidneys), with a large coral stone at the right. Whether an amyloid kidney in the small pelvis is present or whether only a bilateral dystopia of the kidneys exists, cannot be decided from the roentgenograms. Intravenous pyelography, although carried out most carefully, failed in this case.

POLYPS OF MIDDLE EAR

L. Forschner and F. Windholz report on histologic changes in irradiated polyps of the middle ear. Among these, there were two granulation tumors that had disappeared spontaneously following roentgen irradiation; furthermore, a larger blocking antrum polyp, which extended far into the auditory meatus and which offered an opportunity, before and after the irradiation, to make several excisions of tissue, in order to compare the X-ray changes in the tissues with the unirradiated tissue. Finally, a nipple-like elevation in an acute, likewise irradiated middle ear suppuration was examined. First the histologic picture of the unirradiated piece of the blocking middle-ear polyp was demonstrated. After the application of relatively few irradiations a change in the cell content and in the cellular composition of the polyps could be noted. The number of polymorphonuclear leukocytes, lymphocytes, and plasma cells decreased materially, and an increase of the connective tissue cells and of the intercellular substance could be observed. The cell changes, the karyopyknosis, the karyolysis, and the complete degeneration of the leukocytes was demonstrated with a number of photographs. The proliferation of the connective tissue originated in the vicinity of the blood vessels. The latter had undergone varying degrees of modification. The endothelium was swollen, while the stainability of the nuclei had decreased. The protoplasm presented vacuoles and showed degeneration, and the lumen of the vessels was frequently narrowed and gave evidence of degeneration. Also, in the capillary vessels were several layers of large, swollen cells whose nuclei and cell protoplasm gave plain evidence of the previously described conditions, in place of the simple layers of endothelium.

The speakers emphasized also that the spontaneous retrogressive changes of the middle-ear polyps showed a similarity with the demonstrated findings, of which fact they were able to convince themselves by comparison with the unirradiated polyps.

Wittmaak thought he saw a causal connection between the spontaneous healing process in the ear polyps and the degenerative processes in the blood vessels. In the same sense, it appeared not impossible that the reparative process produced by roentgen rays, aside from the direct destruction of the inflammatory cells, also the changes in the blood vessels produced by the irradiation, play a part. It is worthy of note that the appearance and the extension of the changes run by no means parallel with the irradiation dosage and duration, for occasionally after relatively small doses a marked histologic reaction is observed, which possibly, with the exception of the vascular changes, scarcely increases following prolonged irradiation. This circumstance is to be considered also in marking out the plan of irradiation. In the experience of the speakers, it appears indicated, after a few weak irradiations, to await the effect and only after an interval of from four to eight weeks to renew the irradiation; as it has been shown that the therapeutic effect, if it does not appear immediately after the first irradiations, is not perceptibly increased by irradiations continued over a longer period.

EDITORIAL

LEON J. MENVILLE, M.D. . . . . *Editor*
BUNDY ALLEN, M.D. . . . *Associate Editor*

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ANNOUNCEMENT

We have been asked to announce that all correspondence relative to business matters connected with the Radiological Society of North America and RADIOLOGY, the official Journal of the Society, should be addressed to Donald S. Childs, M.D., Secretary-Treasurer, 607 Medical Arts Building, Syracuse, New York.

IS ROENTGENOLOGY, AS A SPECIALTY, DESTINED TO SURVIVE?

Will the interests of scientific medicine be best served, in the long run, by the survival or extinction of roentgenology as a specialty? Does competent diagnosis by means of X-rays demand sufficient special training and study to justify its practice as a medical specialty? Or should it, like inspection, palpation, percussion, and other methods of physical examination, be employed simply as a part of the routine of the surgeon, the internist, the urologist, the general practitioner? These questions are not merely of academic interest to students of medical trends, but are of immediate vital interest to some hundreds of roentgenologists and to some scores of young men now in training for the practice of this seriously menaced specialty.

The existence of specialties in medicine is predicated on the assumption that the theory and practice of modern medicine have grown beyond the grasp of any one man: that no one can any longer be truly a "physician and surgeon" and in addition a urologist, otolaryngologist, etc. Legally, anyone possessed of a degree of Doctor of Medicine and a license to practise in his State may assume and claim special aptitude for the practice of any medical specialty, with none to say him nay. Practically, in urban communities, the amount of harm to be done by the occasional surgeon, the self-trained urologist, the incompetent otolaryngologist, is limited, since the body of medical opinion is against him. He is not encouraged to work in the best hospitals, cases are not referred to him by the qualified and ethical men who mold medical opinion. He must depend for his practice on a personal appeal to a limited circle among the laity. The tendency of the qualified specialist in any line is naturally to resent unwarranted assumptions of special qualifications which do not exist. By this mechanism the position of the well trained man, in most lines, is protected even though existing laws regarding medical licensure take no account of medical progress of the last thirty or forty years.

The position of the roentgenologist is, for a variety of reasons, quite different. The public has been trained, largely through lack of vision on the part of early X-ray workers, to marvel at the physical equipment of the roentgenologist instead of his mental equipment, to see the machine, not the man, to focus its interest on the work of technicians, rather than the work of the man in front of the viewing box. Thus, to most laymen, and unfortunately to too many med-

ical men, an X-ray examination speaks completely and finally for itself without regard to whether or not it is competently interpreted. For this reason there exists almost no public demand for the services of a physician especially trained in X-ray diagnosis, providing any other person, trained or untrained, professes intelligence and ability to take over his function. The cases of the ethical roentgenologist are almost entirely referred by other physicians. He makes no initial or independent contact with his patients. Often in hospital, and sometimes in office practice, he does not even see them, hence he has no opportunity to build up an independent clientèle among the laity. Indeed, he has had no desire to do so, being well satisfied to gain the support and confidence of his medical colleagues. His position, frequently a difficult one through the necessity of maintaining friendly and equable relations with a large group of medical men whose personal interests often conflict violently, is best fortified by his willingness to remain somewhat in the background, making no effort to project his personality upon the patient's attention.

With the advent of the Coolidge tube, the simple, compact, and reliable X-ray transformer, and dependable photographic materials, many of the technical difficulties which hindered the making of satisfactory X-ray films were removed. It became possible for a reasonably intelligent person to learn in a few months to make technically excellent roentgenograms. With the expansion, brought about by war orders, in the factories of makers of X-ray equipment, it became incumbent on their sales forces to find buyers for hundreds of new X-ray outfits. With the growth in the scope of X-ray diagnosis, conditioned by the willingness, indeed the almost frantic insistence, of the public to have X-ray examinations made for any ailment whatever, there was created a great potential market to absorb the over-production of X-ray equipment. Human greed, never a factor to be overlooked but perhaps particularly rampant during the inflation period, was the motif of the sales argument which placed thousands of X-ray machines in the offices of medical men no more versed in roentgenology than in astrology and with no more intention of making a serious study of the one than the other. Let me hasten to add that desire for financial gain was not the only argument. and probably not often the chief argument, by which the surgeon or the internist convinced himself that he ought to take over the work of his roentgenologist. There were other, and in some respects excellent, arguments for this course of action. These will be considered later.

The chief weakness in the roentgenologist's position as a specialist lies in the almost universal application of his specialty. A tremendous proportion of patients seeking relief from illness require an X-ray examination at one time or another. The internist sends a few of his patients to the otolaryngologist, a few to the urologist, a few to the surgeon, but almost all of them require an X-ray examination. He would not think of doing his own appendectomies, or tonsillectomies, or cystoscopies; he has no special training along those lines—to attempt those procedures would be to lose caste. Men who perform them competently send him patients. But how convenient it is to have the necessary X-ray studies made in his own office! And the result of an incompetent X-ray examination is not immediately apparent, not often promptly fatal. The surgeon's problem is similar; the answer frequently the same.

The so-called commercial X-ray laboratory, conducted by technicians with perhaps a medical man nominally, but not actually, in charge, menaces the roentgenologist's position from another angle but to much the same effect. It provides the physician, who does not recognize the desirability of expert medical interpretation of X-ray findings, with a cheap and inexpert X-ray service

without the necessity of investment in equipment. The result, so far as the patient is concerned, is apt to be much the same as though the physician or surgeon referring him to the commercial laboratory had his own X-ray equipment, except that the service may cost him less.

In hospital practice, the theoretic position of the roentgenologist as a specialist is for the most part unassailed. He occupies, however, in the modern hospital set-up, a unique and unenviable position. His relations with other members of the staff are largely of his own making and likely to be most agreeable, though in smaller institutions there may be a slight tendency to rate him somewhere between a laboratory technician and a doctor. But his remuneration for his professional services usually derives from a fee-splitting arrangement with the business management of the institution. The fees are often fixed by the business management at a figure to conform with local practice. If, through his efforts, the roentgenologist succeeds in building up a larger volume of work in his department than the hospital board thought possible when the original arrangement was made, he is very likely to find the business management casting covetous glances at his monthly earnings. If he does not accept a reduction in his percentage, he is apt to be replaced by a cheaper man. Thus the hospital roentgenologist is oftentimes sampling the joys of socialized medicine some years in advance of his confrères.

Clearly any field of endeavor which does not promise adequate reward for effort and considerable scope for ambition will not long continue to attract men of ability. It should not be understood that the tendencies described have become fully effective, nor that they are equally active throughout the country. There are still many roentgenologists in clinics, in hospitals, and in private practice who, so far as their personal experience extends, would hardly realize that roentgenology as a specialty has suffered serious inroads in these past few years. To the majority, however, it is an all too evident fact.

Presumably it is the aim and intention of the medical profession, as a whole, to give the public the most effective possible medical service in the most efficient, feasible manner, efficiency being defined as the ratio of results achieved to effort expended. Does, or can, the roentgenologist earn a permanent place in the ideal scheme of effective medical service which the public expects, and particularly, at this time, demands, in return for its huge outlay? We hear much of the high cost of medical care. Will the survival or the extinction of roentgenology as a specialty best serve to decrease this cost?

There is evident very little tendency on the part of the profession to deny the roentgenologist's superior skill in the interpretation of roentgen findings. This is proven by the regularity with which physicians demand for themselves, their families, and medical men under their professional care the opinion of the full-time, rather than the occasional, roentgenologist. It is shown by the frequency with which the roentgenologist is called on for interpretations, usually as a favor, of films made by the amateur X-ray worker, if the surgeon or internist who operates his own X-ray apparatus may be fairly so called. It is evidenced by the uniformity with which highly trained and usually very well remunerated roentgenologists are employed by great clinics, teaching hospitals, and like institutions. It is, then, not in the interest of greater diagnostic accuracy that private X-ray plants and commercial laboratories are so common.

Considerable stress is often placed on the greater convenience to the physician and the patient of having the X-ray examination conducted in the physician's own office; of the saving in time of having films immediately available for interpretation. This argument has some force. Offsetting it is

the fact that the amateur roentgenologist tends to make his X-ray interpretations conform to his clinical impressions. At the time when he needs an independent and unbiased point of view, he inclines to interpret what he sees in the light of physical findings, history, and laboratory reports. Only the most strikingly contradictory appearances on the films or screen can lead him away from his already made tentative diagnosis. When the patient should have, and is usually paying for, a consultation, he often gets only the empty routine of a roentgenologic investigation. Everyone who has checked closely the roentgen interpretations even of men very able in other lines, who elect to do their own X-ray work, knows that this happens often, causing enough missed diagnoses to controvert the argument of convenience—if the patient's welfare or even the physician's prestige is to be the basis for decision of the usefulness of the roentgenologist. Furthermore, in this connection as elsewhere, time can often be saved, but at too great a cost. Except in emergency, a less hurried and more considered interpretation of dry films makes for greater accuracy.

Turning to the economic aspect, expensive equipment occupying costly floor space can add to efficiency only if it is frequently and profitably used. There are at present in this country, installed in doctors' offices, enough modern X-ray equipment to do the X-ray diagnosis work of the entire world and one or two other planets besides. Most of it stands idle a great part of the time. Obviously the patient pays depreciation and upkeep on this huge collection of machinery. Two-thirds of it is not paying its way even in the narrow sense of bringing its owners sufficient cash return to meet overhead and operating expenses. Such a state of affairs must be abhorrent to the economic-minded examiner into the cost of medical care. Physicians being notoriously poor business men, many owners of such semi-idle equipment do not realize what a financial burden it is. Others, with more acute financial sense, realizing it, are tempted to find more work for it to do, even if the indications for extensive or repeated X-ray examinations do not clearly exist. Thus grows the cost of medical care.

Certainly there can be no just criticism of the physician who, owing to his location, finds it necessary to have his own X-ray equipment or deny his patients, and himself, the protection of X-ray diagnostic service. In this, as in other fields, he does the best he can, often shaming the specialist, and he is only to be complimented.

Objection has sometimes been made to the high cost of X-ray examination. This cost has been sometimes offered as an excuse for installing private X-ray equipment—the physician wishes to protect his patients from the exorbitant charges of roentgenologists. The general run of basic X-ray fees has not changed since 1914, when the dollar had somewhat more buying power in other lines than it now has. The roentgenologist operates under a tremendous overhead expense, and, having no other source of professional income to divert, consciously or unconsciously, to meet a deficit in his X-ray operations, he usually knows about what it costs him to make an X-ray examination. He has no abnormal desire to get rich, which is as well for his peace of mind. It is estimated that the overhead expense of the average, fairly busy X-ray laboratory amounts to 50 per cent of the collections, a proportion considerably higher than obtains in any other medical specialty. Net incomes of roentgenologists, as far as can be learned, average less—not more—than those of other medical men in special practice. It is clear to anyone who studies the figures of overhead and income pertaining to X-ray laboratories that any general reduction in X-ray diagnostic charges can come only through

fuller utilization of existing facilities and through greater volume of work in efficiently conducted roentgen laboratories—not through additional duplication of equipment and scattering of effort.

The roentgenologist who wishes personally to survive, who desires to protect his specialty from what he considers unfair attack, apparently has no recourse save the education of the profession or the public in the need for his specialized effort. He is reluctant to appeal to the public, impersonally and with largely altruistic motives, after the manner of, for instance, the cancer education campaign, though it could be done, as many think, justifiably, ethically, and successfully. Can he succeed in educating his professional colleagues?

Note.—Throughout the above discussion the terms "roentgenology," "roentgenologist," "roentgen laboratory," etc., have been employed as applying to the use of X-rays in diagnosis only. There is relatively little tendency on the part of the profession at large to encroach on the treatment field, a fact which has proven the salvation of many radiologists.

CHARLES D. ENFIELD, M.D.
Louisville, Ky.

RADIOLOGIC EDUCATION

RADIOLOGY presents this, its Educational Number, containing different articles of educational interest, so that its readers may have a true conception of the status of radiologic education in the United States and Canada.

It was thought for a long time that, because radiology is a highly specialized branch of medicine, it should be taught only in the graduate schools of medicine; for this reason many of the undergraduate schools held it to be of minor consequence. The science of radiology has advanced so rapidly since then that at present it is considered essential in the undergraduate curricula of medical schools.

An examination of the report contained in a paper entitled "A Statistical Study of Radiologic Teaching in the Medical Schools of the United States and Canada," appearing in this issue of RADIOLOGY, shows much interesting and valuable information. Each of the 81 recognized schools of the United States and Canada gives a substantial number of hours to the teaching of radiology. It is interesting to note that six of our schools offer 20 hours of radiology in the freshman year and 10 schools offer 95 hours in the sophomore year. Canada does not give radiologic instruction in the freshman year, but one school offers 30 hours in the sophomore year. One of the main reasons why radiology is being given this consideration in freshman-sophomore medicine is because of its practical application in some of the subjects, particularly anatomy and physiology, taught in these years.

For years the only means of teaching anatomy was principally by demonstrations on cadavers, but to-day, with the use of the roentgen ray, anatomists are teaching the structure of the living. Oscar V. Batson, M.D., a well known anatomist, once said, "I have taught first-year medical students and first-year dental students, and I am now teaching graduate doctors, preparing for special fields of practice. I have excellent opportunity to observe a bird's-eye view of the results of medical school teaching in anatomy and I am more convinced than ever that the teaching of anatomy must be in fact the teaching of anatomy of the living."

Likewise, the roentgen ray has a distinct application for teaching purposes in the other fundamental branches of medicine—physiology, pathology, etc. It can be appreciated, therefore, that radiologic teaching is not restricted to the clinical, or the last two years of medicine, but a fair amount of time

is also given to the students in the first two years.

It is most gratifying to observe that a large number of medical schools have separate Departments of Radiology, also that many of the radiologists connected with these departments hold professorial positions, and but a very small percentage occupy minor positions, such as assistants and lecturers in radiology. Then, again, we find that a total of 1,797 hours is assigned to the teaching of radiology in our medical schools and 293 hours in the Canadian schools, a grand total of 2,090 hours for both Canada and the United States.

This large number of hours devoted to the teaching of radiology is but another evidence of the importance in which radiology is held. Its recognition on a parity with other highly specialized branches of medicine was to be expected, but that its recognition should come from such authoritative sources is the highest tribute paid to radiology since its very inception. While radiologists have always been proud of the marvelous progress of their specialty, they have refrained from any ostentatious demonstrations concerning its exalted position in medicine. On the contrary, they have perhaps been too modest in proclaiming its many achievements. This may explain why so few of us know of the important position radiology occupies in the curricula of our medical schools. Even the Council on Medical Education of the American Medical Association apparently failed to appreciate fully its importance in this regard. A communication received from this body in 1930, in answer to an inquiry regarding radiologic teaching in medical schools, stated that most medical colleges do not require a student to take a course, or courses, in radiology. Most of them, the Council said, have short elective courses, either in the radiologic department or combined with medical clinics. Nor are there any requirements listed for radiology in their publication, "Essentials of an Acceptable Medical College." They further state that all of the medical students receive some instruction in X-ray interpretation and this is continued in the interne, or fifth, year. The inference drawn from this communication was that radiology was not held in very high esteem by our medical schools. Yet we offer proof to the contrary.

There can be no argument as to the future of radiology in medicine, as it has established itself so firmly and become so indispensable that its continued progress can safely be predicted. In spite of the large number of hours now devoted to radiologic teaching, numerous medical schools believe that more time should be given this subject.

The present status of radiologic education is such that it should attract the attention of the Council on Medical Education of the American Medical Association, the National Board of Medical Examiners, the Federation of State Boards of Medical Examiners, the American College of Surgeons, the American College of Physicians, organized medicine, and organized radiology. All of these, by their kind consideration of the material contained in this issue of RADIOLOGY, can exert a tremendous influence in those States which have not as yet appreciated that a radiologist is a physician deserving of being considered on an equal basis with other members of organized medicine.

IN MEMORIAM

Arthur C. Heublein, M.D., died in Hartford, Connecticut, on April 8, 1932, at the age of 52, following a two months' illness from pneumonia, with complications.

Dr. Heublein became interested in radiology almost twenty-five years ago, and he devoted all his time and energy to this specialty until his death. He was a member of

all the radiological societies in this country, and on the staffs of several hospitals in Hartford and neighboring cities, either as attending radiologist or consultant. About two years ago he was appointed consulting roentgenologist to the Memorial Hospital, New York.

Those who knew Dr. Heublein intimately were impressed by the unusual ability, earnestness, and sincerity which he exhibited in the practice of radiology. He was a true physician, ministering to the sick always to the best of his ability, and with the best interests of his patients at heart. The pleasure he derived from his work he regarded as sufficient compensation for his efforts.

On account of his innate modesty, Dr. Heublein wrote few papers, although his knowledge of the subject and his personal contributions to it fully justified the publication of many more. He was actually distressed when his friends insisted that he read a paper at one of the radiological meetings.

Dr. Heublein's keen analysis of the problems of radiation therapy and his ingenious methods of attacking them may be appreciated from the following examples: At the time when unfiltered glass "seeds" were used for interstitial radium therapy, and beneficial effects were attributed to the beta rays emitted by these seeds, Dr. Heublein thought the beta rays were harmful and should be eliminated. Accordingly he conceived the idea of surrounding each glass seed in the tissue with a sufficient layer of bismuth paste to absorb the beta rays in the region where intense necrosis was produced by the seeds. He worked out a combination of trocar and syringe which made possible the practical application of this idea. After some preliminary experiments on animals, Dr. Heublein treated some patients in this way both in Hartford and at the Memorial Hospital. The development of gold implants made the more complicated procedure with bismuth paste unnecessary, but the fundamental idea is the same and is generally accepted to-day.

The late Arthur C. Heublein, M.D.

The experiment which best characterizes Dr. Heublein's type of mind is the one which, indirectly, caused his demise. For years he had been disturbed by the poor end-results obtained by ordinary means of treatment in cases of generalized neoplastic disease, even of the radiosensitive type. He was convinced that the range of successful radiation therapy could be extended to include at least some of these patients, if the proper method were used. He set out to devise such a method, and he arrived at the following conclusions: Since tumors in these cases are apt to be present in any part of the body, the entire body should be irradiated. Furthermore, the irradiation should be such as to reach the deep structures. Hence a long target-skin distance and hard X-rays should be used. To avoid injury to

normal organs, while attempting to influence favorably the tumor processes, the patients should be irradiated with a very low intensity for a long time.

Realizing that such a method of treatment could be given a thorough practical test only in a large cancer institution, Dr. Heublein made arrangements with the Memorial Hospital to carry out this work. A suitable ward in which four patients could live in a beam of X-rays for two or three weeks at a time was constructed last year, and the first patients were treated in May. The clinical work has been carried out since then under the direct supervision of Dr. Heublein and a special committee of the Medical Board.

Dr. Heublein used to spend two days a week at the Memorial Hospital in connection with this work. He was so interested in the experiment that, without exaggeration, he spent the rest of the week in Hartford looking forward to his next visit to the Memorial Hospital. The last time he came to New York he was ill and was advised to return home immediately. But he stayed for another day, and a few days later hovered between life and death. He passed this crisis successfully, only to succumb eight weeks later.

Dr. Heublein read a paper on his work at the Memorial Hospital at the meeting of the Radiological Society of North America in St. Louis.[1] Since then, a great deal of interest has been shown in the experiment. Prominent radiologists in this country and abroad have said that the eyes of the radiological world are now focused on two experiments of equal importance: (1) The continuous irradiation of the entire body, and (2) the use of X-rays approaching the quality of gamma rays. The former has been referred to by some one as the "telepanirradiation method," but if such a term is to be used, the method will be known as the "*Heublein* telepanirradiation method."

[1]Soon to be published.

As to personality and character, no adequate superlatives can be found to convey the proper meaning. And so this brief sketch may be concluded by saying that radiology has lost a lucid mind and devoted worker, and the world a real gentleman.

G. FAILLA, D.Sc.

ANNOUNCEMENTS

A MEMBER OF THE SOCIETY HONORED

The Royal Society of Medicine, of England, through its Secretary General, Mr. Geoffrey R. Edwards, of London, has notified Byron H. Jackson, M.D., of Scranton, Pennsylvania, of his election as a Corresponding Honorary Member of the Society.

Others elected at the same time were: Prof. Gösta Forssell, of Stockholm, Sweden; Dr. J. Murdoch, of Brussels, Belgium; Prof. Dott Mario Ponzio, of Turin, Italy; Prof. F. Haenisch, of Hamburg, Germany, and Prof. H. R. Schinz, of Zurich, Switzerland.

The radiologists of America are particularly pleased to note that this eminent society has seen fit to select for such signal honor one who ranks so high in his own country as does Dr. Jackson. The Radiological Society of North America likewise is sensible of the honor paid to its President-elect. The Journal tenders its congratulations.

INTERNATIONAL CONGRESS ON BILIARY LITHIASIS

This Congress will be held at Vichy Sept. 19-22, under the presidency of Professor Paul Carnot. Of the four sections into which the program is divided, one is devoted to radiology and physiotherapy.

The program and full information may be obtained by writing to Dr. J. Aimard, Secretary General, 24 Boulevard Capucines, Paris (IX), France.

CINCINNATI RADIOLOGICAL SOCIETY

The radiologists of Cincinnati have recently organized the Radiological Section of the Academy of Medicine of Cincinnati. Membership in this group is limited to those who practise radiology or roentgenology exclusively and who belong to the Academy of Medicine.

Informal monthly meetings are to be held in the various X-ray laboratories in the hospitals of the city. It is planned to present a radiological program before the entire Academy of Medicine each year. The officers for the current year are Samuel Brown, M.D., President, and Harold G. Reineke, M.D., Secretary.

CLEVELAND RADIOLOGICAL SOCIETY

The officers of the Cleveland Radiological Society are: A. Strauss, M.D., President, and Merthyn A. Thomas, M.D., Secretary and Treasurer. The regular annual meeting takes place in May. Regular meetings are monthly on the fourth Monday. At each meeting a regular program is presented.

ANNUAL MEETING OF THE AMERICAN SOCIETY OF RADIOGRAPHERS

The annual meeting of the American Society of Radiographers is to be held at the Hotel Statler, St. Louis, May 24-27, 1932.

A most interesting program is being prepared. The following are to present papers on "Doctors' Day," Thursday, the 26th:

D. A. Rhinehart, M.D., of Little Rock, Ark.; Harold Swanberg, M.D., of Quincy, Ill.; P. C. Schnoebelen, M.D., of St. Louis; Llewellyn Sale, M.D., of St. Louis; Arthur E. Strauss, M.D., of St. Louis; F. D. Gorham, M.D., of St. Louis; John S. Young, M.D., of East St. Louis; Duff S. Allen, M.D., of St. Louis; Bertram C. Cushway, M.D., of Chicago; Robert S. Landauer, Ph.D., of Chicago, and Robert A. Arens, M.D., of Chicago.

Edwin C. Ernst, M.D., of St. Louis, is to act as Toastmaster of the annual banquet (Thursday evening), with the following speakers: LeRoy Sante, M.D., Paul C. Schnoebelen, M.D., Paul C. Titterington, M.D., E. C. Jerman, D.Sc., and R. E. Lee. The speaking is to be followed by entertainment, music, and dancing.

Many interesting subjects are to be presented by the Radiographers, including a chest symposium by the St. Louis Society of Radiographers on the opening afternoon. Wednesday evening there is to be a Round Table Discussion led by D. A. Rhinehart, M.D., assisted by E. C. Jerman, D.Sc., to which the Radiographers may bring their confusing problems and an attempt will be made to solve them. The whole meeting will be well worth the time of anyone wishing to attend.

VIRGINIA H. ELLER, R.T.,
Chairman of Program Committee.

NOTE

Readers will note the omission of Abstracts of Current Literature from this issue. This does not indicate a future policy or any lack of material, but is done simply that more space may be devoted to the papers which constitute this Educational Number.

BOOK REVIEWS

TECHNIQUE DE L'OSTÉO-SYNTHÈSE, ÉTUDE DE QUELQUES PROCÉDÉS. By ROBERT DANIS, Professor of Clinical Surgery, at the University of Brussels. A paper volume with 162 pages and 149 figures. Published by Masson et Cie, Paris, 1932. Price, 55 francs.

This book presents a method of open reduction of fractures by the use of sutures of non-oxidizable steel wire. Much detail of technic

is offered, adequately explained and well illustrated. The author has described a table which may be used not only for abdominal work but, with its various attachments, is suitable for all sorts of fracture work. (Invented by Man, of Angiers.) Special motor drills, instruments to pass the wires, and instruments to secure these as sutures are described. Finally, an instrument to fuse the ends of the wire sutures is described and its use illustrated.

Another form of fixation by a special screw with threads on the distal end and much wider spaced than usual is described, also a fixation material of wire mesh held with wires, all of non-oxidizing steel, is described.

With these combinations of methods the author is able to accomplish reduction of the various types of fracture by open method. He describes special apparatus for taking preoperative as well as post-operative X-rays.

Some space is devoted to a description of bone-grafting technic in non-union. A specially devised motor saw is illustrated, the graft being held in place by autogenous bone screws. The graft is of the type known in this country as "inlay grafts." No case illustration of this method is given. The method is no doubt valuable in the hands of the author, but the complexity of the apparatus described and of the methods used makes its wide adoption unlikely.

LES TUMEURS DES OS (TUMORS OF BONE). By J. SABRAZÈS, Professeur à la Faculté de Médecine; Chef de service au Centre Anticancéreux de Bordeaux et du Sud-ouest: G. JEANNENEY, Professeur agrégé à la Faculté de Médecine; Chirurgien adjoint au Centre Anticancéreux de Bordeaux et du Sud-ouest; R. MATHEY-CORNAT, Électroradiologiste des Hôpitaux; Chef de Laboratoire au Centre Anticancéreux de Bordeaux et du Sud-ouest. Pages, 437, with 165 figures. Published by Masson et Cie, Paris, 1932. Price, 80 francs.

This volume covers in a concise and well-arranged manner the present knowledge of bone tumors. The authors have arranged the material in a manner somewhat different from the classifications accepted in this country. However, their reasons for thus classifying these tumors are well stated and, in the light of our present knowledge, may be said to be as acceptable as any of the other classifications thus far offered. In the introduction the classifications of Codman (Registry Classification), Kolodny, Ewing, and Geschickter are given.

The authors have divided their book into three parts, as follows:

I. Benign bone tumors, *i.e.*, chondromas, osteomas, exostoses, fibromas, lipomas, myxomas, and angiomas of bone.

II. Giant-cell tumors. This part includes also bone cysts and osteitis fibrosa.

III. Malignant bone tumors, primary and secondary, *i.e.*, osteogenic sarcoma, Ewing's sarcoma and myelomas or chloromyelomas, and, finally, metastatic tumors.

In each section there is a discussion of the historical aspects of that particular tumor, its clinical and pathological manifestations, including the roentgenographic findings, the value of biopsy, and the treatment, including surgery and X-radiation. Each type of tumor is considered as fully as its importance seems to justify. The authors quote freely from other writers and there is included a well-arranged and very complete bibliography on the subject of bone tumors. The illustrations consist chiefly of excellent roentgenograms which are amplified in each instance by an adjoining pen-and-ink sketch depicting the significant changes. The photomicrographs have not reproduced well and in some cases are rather disappointing.

The authors have attempted and have succeeded quite well in bringing the subject matter pertaining to bone tumors up to date. This is a very difficult task, since in treating of a subject like bone tumors, changing conceptions are constantly before us. However, as a text-book devoted to this subject, this book can be recommended as among those of first rank.

PRÉCIS DE RADIO-DIAGNOSTIC. By P. LAMARQUE, Professeur agrégé à la Faculté de Médecine de Montpellier, with a Preface by PROF. E. FORGUE, Associé National de

l'Académie de Médecine, Membre correspondant de l'Institut. There are 374 radiographs and explanatory line drawings supplementing the text (746 pages). Published by G. Doin & Cie, Paris, 1932. Price, 125 francs.

This book aims to serve as a text for students of radiology and as a reference book for general practitioners. For that reason the purely technical aspects of radiography, description of apparatus, controversial questions, and citations of the literature are largely omitted by the author, being treated in a superficial way merely to emphasize some clinical point. The presentation of the subject matter is so facile and concise that anyone knowing even the fundamentals of French can read the book with much profit. In the first brief chapter (pages 1-13) apparatus is discussed. The skeleton and its lesions are considered in the second chapter (pages 23-249). The respiratory system is considered in Chapter III (pages 253-361), the cardiovascular in the fourth chapter (pages 363-398). The chapter on the gastro-intestinal tract covers pages 403-598; the seventh chapter (pages 601-636) concerns itself with the urinary tract, and the eighth (pages 639-668) the genital. The "specialties" are next discussed briefly: otorhinolaryngology on pages 671-684, ophthalmology on pages 685-690, neurology on pages 693-706, and stomatology on pages 707-715. In each chapter the normal is presented as a basis of comparison with the pathologic both in the text and in the reproductions of radiographs, each of which has an explanatory line drawing. As far as the reviewer knows, this is the best single-volume presentation of the subject to the student or beginner in radiology, yet the specialist may well read the book with profit.

The make-up of the book is first-class, though it does suffer from the mediocrity of many of the cuts. It rather seems that it would have been worth while to make many of them full, rather than half, page in size, which fault will undoubtedly be corrected in future editions.

TUMORS OF THE BREAST: THEIR PATHOLOGY, SYMPTOMS, DIAGNOSIS, AND TREATMENT. By SIR G. LENTHAL CHEATLE, K.C.B., C.V.O., F.R.C.S., Consulting Surgeon and Emeritus Lecturer on Surgery, King's College Hospital, London; Late Surgeon to and Lecturer on Surgery at King's College Hospital, London; Walker Prizeman, 1926-1930; and MAX CUTLER, B.Sc., M.D., Director of Tumor Clinic, Michael Reese Hospital, Chicago; Late Clinical Fellow, Memorial Hospital, New York; Director of Research Division of Cancer Department of Hospitals, New York; Attending Radiation Therapist, New York City Cancer Institute. J. B. Lippincott Company, Philadelphia, 1931. Pages 596, with 18 colored plates and 468 other illustrations. Price $12.

This massive volume is the most recent and probably the best comprehensive study published on breast tumors. The contents, collected from the literature and from thirty-five years of experience, reveals a wealth of material which is of inestimable value to all students of breast pathology. The compilation of this material bespeaks tedious, persevering, and concentrated effort.

The book is subdivided into fourteen chapters, each containing a complete bibliography. The long, tedious discussions and occasional repetitions sometimes carry the reader far away from the original trend of thought and leave him with uncrystallized ideas.

The microscopic, whole breast sections giving the detailed location and extent of tumefactions, together with the histopathological picture of the surrounding tissues, are one of the most attractive features of the book. They are distinctly an advance in the study of breast pathology.

The division of epithelial growths into desquamative hyperplasia and neoplasia is an interesting feature of the new classification. Desquamative hyperplasia includes mazoplasia and cystiphorous changes. Mazoplasia comprises the more physiological tumefactions of "chronic cystic mastitis" and may be treated by ovarian residue. Cystiphorous desquamative epithelial hyperplasia is considered as the

other phase of desquamative hyperplasia and is distinguished from mazoplasia by its susceptibility to undergo benign and malignant changes. The malignant change is reported to be 20 per cent of all cases of breast carcinoma.

Cysts are believed to arise in the acini and carcinoma to arise in the ducts. Small cysts, which are usually seen in multicystic conditions, are more susceptible to benign and malignant changes. Because of the possibility of carcinoma arising in cystiphorous changes of the breast, these changes are considered as menacing neoplastic states and are treated by routine mastectomy; if malignancy is found, they are treated by radical amputation. Frozen sections are made after the removal of the breast.

All papillomas are believed to ultimately become malignant. A single papilloma is considered as having a bad prognosis for, unless a whole section of the breast be examined microscopically it is impossible to say that the growth is single. When removed, the stimulus causing the first papilloma may cause the formation of others, and for these reasons, a papilloma is regarded as a pre-cancerous condition and is treated by mastectomy.

The discussion of carcinoma is based on the location of the growth and is presented fully from the angles of histopathology, modes of extension, grades of malignancy, radiosensitivity; diagnosis by inspection, palpation, transillumination, and biopsy and treatment by surgery and irradiation. The diagnosis of carcinoma is rendered according to the cellular pathology regardless of the presence of intact basement membranes. A few such cases showing metastasis are demonstrated by the authors. The differential diagnosis covers the major field of breast pathology.

Transillumination is thoroughly discussed. The points of differentiation between cystic, papillomatous, and solid tumors are made clear and a warning against over-illumination given.

Paget's disease of the nipple is amply covered by seventeen beautifully illustrated and completely worked up cases. The disease is considered as a primary one and though there seems to be a relation between duct carcinoma and Paget's disease, carcinomatous changes occurring in the breast are considered as spontaneous and independent.

Sarcoma occurs in from 2 to 3.9 per cent of breast tumors. Round-cell sarcoma is considered the most malignant and giant-cell sarcoma the least malignant. The majority of the sarcomas are radioresistent, but some are highly radiosensitive.

Irradiation, in general, more quickly affects anaplastic lesions. In carcinoma of the breast a small number of cases show great radiosensitivity, but the majority show slight, and, in a small number of cases, no radiosensitivity. In spite of the fact that cure in late cases, occurring in old individuals, cannot be effected, a growth restraint, by sublethal doses can be produced. Finally, it is admitted that irradiation is still in the experimental stage.

The book is an excellent survey of breast tumors and clearly demonstrates the degree to which breast pathology has become specialized. It is not the book for a novice, but nevertheless should prove an invaluable aid both as an atlas and as a reference to students, practitioners, and specialists.

JOHN G. MENVILLE, M.D.

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